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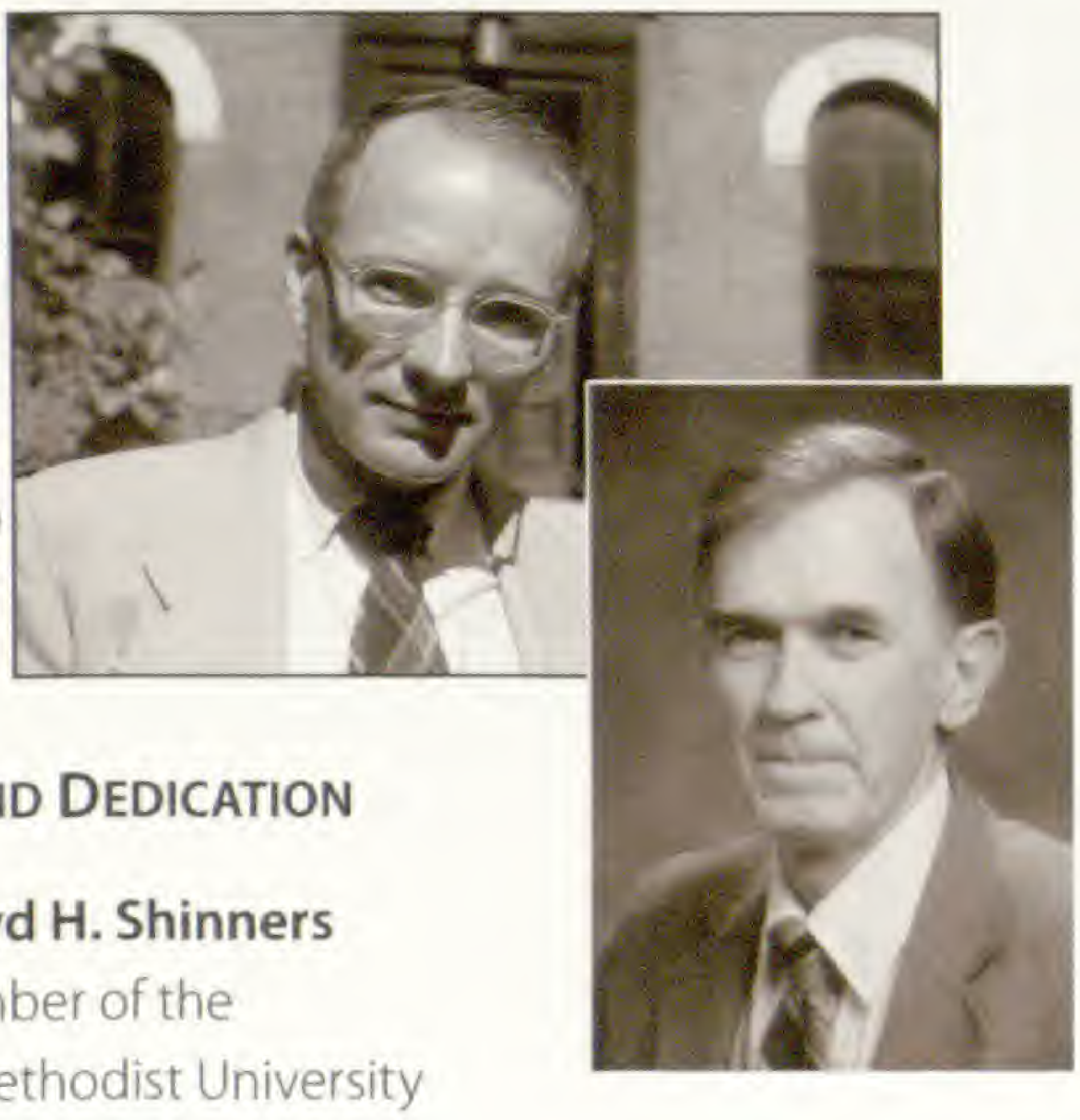

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AGALINIS FLEXICAULIS SP. NOV. (OROBANCHACEAE: LAMIALES), A NEW SPECIES FROM NORTHEAST FLORIDA

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ABSTRACT

Agalinis flexicaulis Hays, sp. nov., is described from collections in Bradford County, northeast Florida. This new species is found in hydric to mesic soils of wiregrass communities or remnants thereof. A key to the long-pediceled species of *Agalinis* in Florida is provided to help distinguish *A. flexicaulis* from other species.

RESUMEN

Agalinis flexicaulis Hays, sp. nov., se describe de las colecciones del Condado de Bradford, en el noreste de Florida. Esta nueva especie se encuentra en los suelos húmedos de las comunidades de Wiregrass. Se aporta una clave para las especies de pedicelos largos de *Agalinis* en Florida para distinguir *A. flexicaulis* de otras especies de *Agalinis*.

Field work in preparation for the author's forthcoming treatment of *Agalinis* Raf. in volume 17 of the *Flora of North America*, in collaboration with Judith Canne-Hilliker of the University of Guelph, Ontario, has resulted in the discovery of an unknown species of *Agalinis*.

Agalinis flexicaulis Hays, sp. nov. (**Fig 1**). TYPE: UNITED STATES. FLORIDA. Bradford Co.: HY100, E side of road, 2.7 mi SSE from the town of Starke, ca. 29°54'21.07"N, 82° 5'26.16"W, in remnant prairie vegetation dominated by *Aristida longespica, A. stricta,* and *Andropogon virginicus*, 14 Oct 2009, *J. Hays 3452* (HOLOTYPE: NY; ISOTYPES: BRIT, MO, OAC).

Agalini obtusifoliae similis sed differt caulibus longis laxis paniculis distantibus, corollis minoribus roseis, et ad apicem capsulae oblonga nervis insigniter prominentibus.

Annual, hemiparasitic herb, roots fibrous, haustoria present, host plant(s) unknown, 2.5–9.0 dm tall, often tinged purplish along upper surfaces of stem faces, remaining greenish when promptly pressed, turning purplish-maroon if allowed to air dry. **Stems** spreading-ascending, single from the base, the lower branches on larger plants decumbent-ascending, to 6 dm. Stem sub-terete below, becoming strongly four-angled above, stem faces glabrous, callous angles glabrous to minutely scabridulous, rounded, trichomes antrorse, but both perpendicular and retrorse trichomes occasionally present. **Leaves** opposite, often sub-opposite or alternate on ultimate branches, spreading to spreading-ascending above. **Axillary fascicles** absent. The leaves at mid-stem 7–13 mm long, linear to linear-spatulate (the lowermost leaves sometimes narrowly elliptic), 0.8–1.5 mm wide, stiff but fleshy, u-shaped in cross section, the upper surface slightly concave when fresh, becoming involute or folded upon drying, tips obtuse to acutish, silicified. *Upper surfaces* of leaves and margins scabrous with silicified trichomes, noticeably so upon drying, *lower surfaces* glabrous save some trichomes on midveins. **Inflorescence** indeterminate, paniculate-racemose, racemes and panicles remote, panicles sometimes as much as 5 dm removed from the main stem on larger plants. Flowering branches with 3 to 8 floriferous nodes, ultimate flowers solitary, not paired (though often appearing as such). **Pedicels** slender, clavate, terete, spreading, glabrous, often two-toned, purplish-maroon above and green below, 4–12 mm at anthesis, to 20(±22) mm in fruit, lowermost pedicels of raceme decidedly longer than those above in flower and fruit. The pedicel indistinct from base of calyx in flower. Bracts of ultimate, fully-developed flowers 0.5–4 mm long, linear-spathulate, ascending-appressed with the pedicel. **Calyx at anthesis** long campanulate to campanulate-turbinate, glabrous, tube 2.2–2.7 mm long, often two-toned, upper surface purplish-maroon, lower surface green; lobes 5, minute, acute, deltoid to subulate, 0.2–0.5 mm long, pu-

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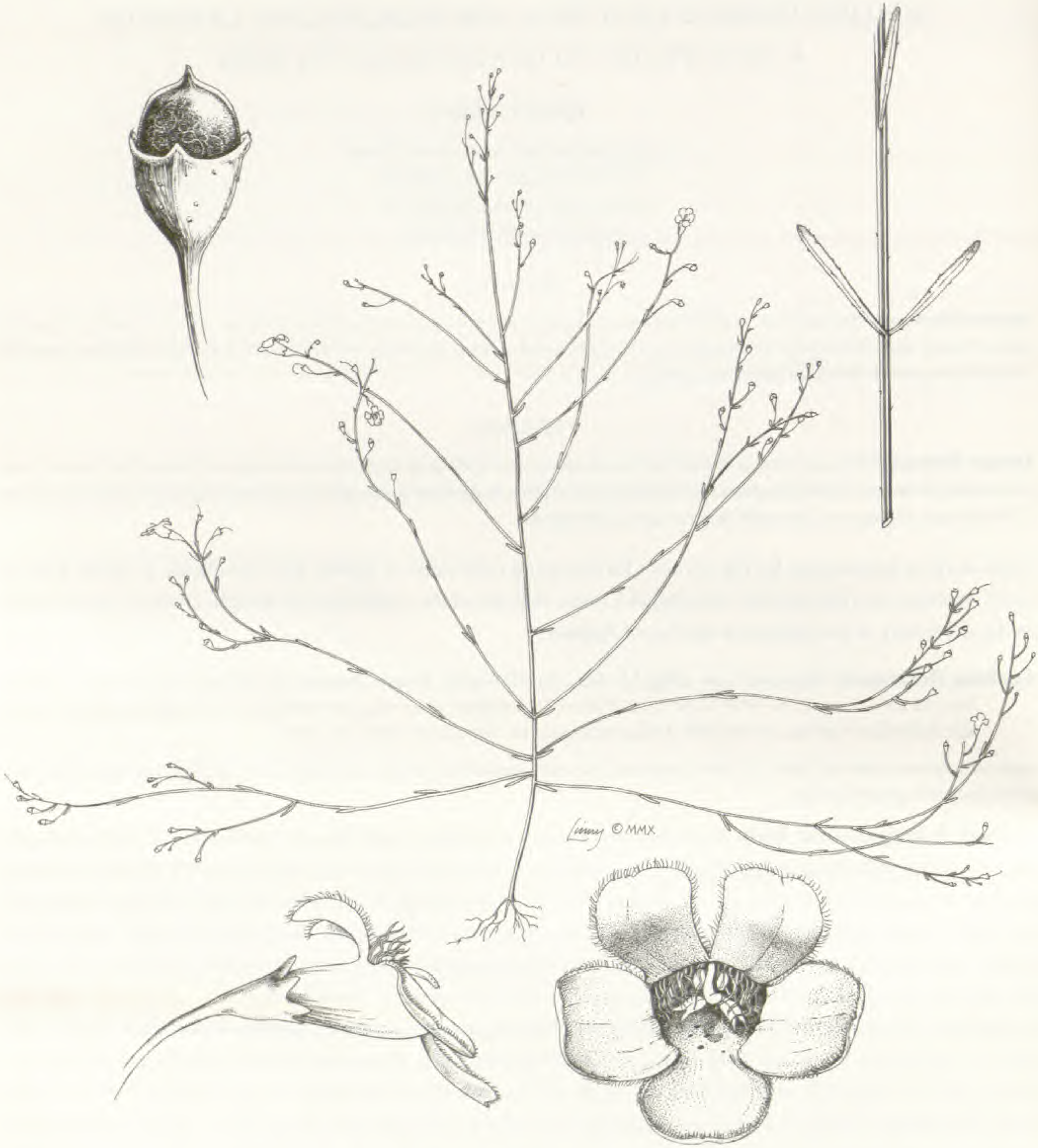

Fig. 1. ***Agalinis flexicaulis*. A. Habit. B. Corolla, side view. C. Corolla, front view. D. Mature capsule. E. Partial cross-section of stem. Illustration by Linny Heagy©2010.**

berulent within with silicified trichomes, callous-silicified, most evident upon drying, sinuses v-shaped to broadly rounded. **Calyx in fruit** oblong to hemispherical, 2.4–3.4 mm long, reticulate venation conspicuous and raised, small protuberances often present, sometimes minute, erect, silica-filled trichomes arising from calyx surface, some calyces splitting vertically on one side as fruit matures, lobes recurved, sinuses broadly concave to truncate. **Corolla** zygomorphic, as measured from base of tube to apices of upper two lobes, 10–12 mm long, rose-purple, the throat paler than the 5 lobes, some corollas with a few rose-purple spots abaxially within, yellow guidelines absent; *tube* 1.5–2.0 mm long, white, *abaxial throat* ±6 mm long, *adaxial throat* ±4.5 mm long, throat narrow, upcurved, soft-pubescent externally, otherwise glabrous. **Co-**

rolla lobes spreading, shorter than tube, surface of all lobes glabrous externally and internally above the sinuses. *The two upper lobes* 3–4 mm long, ±3 mm wide, apex truncate, emarginate, or sometimes erose-cordate, strongly pink-ciliate, often reflexed above the middle of the lobes, lanose across the base of lobes with pink trichomes to 1.2 mm long. *The three lower lobes* 4–5 mm long, 2.5–3.0 mm wide, apex truncate, emarginate, or sometimes erose-cordate, ciliate, the central lobe with shorter cilia. **Stamens** didynamous, abaxial filaments 3.9–4.2 mm long, pubescent basally, adaxial fliaments 2.4–3.0 mm long, glabrous. **Anthers** 4, apices rounded, bases mucronate to apiculate, white when fresh, valvular surfaces lanose, abaxial anthers elliptic, held mostly perpendicular to the filaments, apices often connivent by a dense entanglement of trichomes 1.2–1.8 mm long, adaxial anthers linear-oblong, held parallel to filaments, 1.5–2.0 mm long. **Style** 5–7 mm long, exsert, glabrous, white-translucent, *stigma* ±1 mm long, white, papillate. **Capsule** long obovoid to oblongish, broadly 4-sided, ± as wide as broad, 3.8–4.5 mm long at maturity, apex golden brown when mature, greenish-tan beneath calyx tube, apex truncate, appearing broad-shouldered along margins of callous ridge, base broadly cuneate, conspicuously-reticulate veined on the upper one-third of mature capsules, with scattered, minute, silica-filled trichomes often on surface of the capsule above the adhering calyx; callous ridge on capsule perpendicular to the septa, extending from the apex transversely downward to the base along opposite sides. **Seeds** triangular to quadrangular, lustrous golden-brown, minute, ±0.5 mm long, testa reticulate. **Chromosome number** unknown.

Flowering from late September through early November, fruiting into late November. Occurring in mesic to hydric prairies or longleaf pine savannas dominated by wiregrass (*Aristida* spp.) and the remnants of such communities (Table 1). Currently known only from five populations in southern Bradford County, Florida. Apparently endemic. It is, however, to be expected in the following portions of adjacent counties: the northern one-third of Alachua County, SW Clay County, NW Putnum County, and the southern half of Union County.

Additional collections examined: **FLORIDA, all Bradford County:** Type locality, 17 Oct 2009, *Hays* 3453 (FLAS, USF); CR 18, 2.1 mi W of jct. of CR18 & SR100 on south side of road in remnant moist prairie/savanna, ca. 29°51'9.30"N, 82°5'57.04"W, 35 + plants in flower and early fruit, 17 Oct 2009, *Hays* 3454 (PH); CR225, 2.9 mi ESE from jct. of CR 225 and HY 301, ca. 29°52'43.03"N, 82°11'7.03"W, 40 + plants in flower and early fruit on S side of road in longleaf pine savanna, 24 Oct 2009, *Hays* 3455 (BRIT, MO, USF); CR 221, 0.3 mi S of jct. of HY301 and CR221, ca. 29°53'12.98"N, 82°8'17.06"W, 50 + plants in late flower and fruit along margin of regenerating longleaf pine savanna, 31 Oct 2009, *Hays* 3456 (FLAS, MO); SR100 west, 7.6 mi W of jct. of SR100 & HY301, and 0.8 mi E of jct. of CR 235 and SR100, ca. 29°58'44.41"N, 82°14'0.13"W, 60 + plants in fruit in remnant prairie vegetation beside regenerating longleaf pine plantation, S side of road, 1 Nov 2009, *Hays* 3457 (BRIT, FLAS, MO, NY, USF).

Common name.—Hampton False Foxglove; Sprawling False Foxglove. The common names are taken from the small town around which most of the original collections were made, and the obvious decumbent, flexous habit of larger branches on mature specimens.

Etymology.—The specific epithet "flexicaulis" was chosen to aptly describe the sprawling, decumbent branches so characteristic of the secondary and tertiary branches of the larger specimens of this species.

Agalinis flexicaulis is yet another elusive, but distinctive species of North American *Agalinis* that seems to melt into its surrounding habitat (Hays 2002). This species is unique among North American members of the genus because of its weakly ascending main stem, which becomes more drooping and lax as it matures, as well as the remote panicles (Canne-Hilliker & Kampny 1991; Pennell 1929). The secondary stems (especially the lower ones) are often 4 dm or more long, decumbent-ascending as the larger branches often droop toward the ground in the middle and then slightly arch upward toward their tips, supported by surrounding vegetation (mostly grasses) to expose the flowering branches. As mature capsules develop, the main stem leans toward one side and the long secondary flowering branches are near, on the ground, or entangled within surrounding vegetation, which often grows over the branches as the season progresses. Latent flowers often appear to arise from the ground on severed stems. The plants often need to be pulled gently, branch by branch, from the vegetation supporting them to avoid breaking the stems or losing leaves, flowers, or fruit. It is also common to see plants with decidedly secund branching, although not exclusively so.

Bradford County is part of the Northern Highlands physiographic province, with much of the county

Table 1. List of taxa associated with *Agalinis flexicaulis*.

Associate Species	**State of Florida Wetland Status**	**Associate Species**	**State of Florida Wetland Status**
Aletris lutea	FAC	*Kalmia hirsuta*	UPL
Amphicarpum muhlenbergianum	FACW	*Lachnocaulon anceps*	FACW
Andropogon virginicus	FAC	*Liatris spicata*	FAC
Aristida longespica	UPL	*Ludwigia hirtella*	FACW
Aristida stricta	FAC	*Mitreola sessilifolia*	FACW
Bulbostylis stenophylla	UPL	*Panicum longifolium*	FACW
Carphephorus paniculatus	FACW	*Panicum verrucosum*	FACW
Centella asiatica	FACW	*Pinus palustris*	UPL
Chaptalia tomentosa	FACW	*Pluchea baccharis*	FACW
Dichanthelium acuminatum	UPL	*Polygala lutea*	FACW
Dichanthelium aciculare	FACW	*Polygala setacea*	FACW
Dichanthelium scoparium	FACW	*Rhexia cubensis*	FACW
Drosera capillaris	FACW	*Rhexia petiolata*	FACW
Eragrostis spectabilis	FAC	*Sabatia brevifolia*	FACW
Eragrostis elliottii	FAC	*Scleria reticularis*	FACW
Euthamia minor	FAC	*Symeria cassiodes*	FAC
Eryngium yuccifolium	FAC	*Symphyotrichum adnatum*	UPL
Gratiola hispida	FAC	*Symphyotrichum dumosum*	FAC
Helianthus radula	UPL	*Vaccinium myrsinites*	UPL
Hypericum tetrapetalum	FACW	*Xyris caroliniana*	FACW
Hyptis alata	FACW	*Xyris floridana*	OBL
Ilex glabra	UPL		

having geologic and topographic characteristics of a large basin (Randazzo & Jones 1997; Dearstyne et al. 1991). The author visited approximately 100 potential sites in Bradford and adjacent counties in October and November of 2009. The following counties were visited: Baker to the north, Clay to the east, Alachua to the south, and Union to the west. Numerous habitat types were visited in an attempt to assess where this new species is most likely to occur: longleaf pine savannas, wet and dry prairies, seepage slopes, Florida scrub, pine flatwoods and high pine, and open, ruderal areas were native vegetation still exists in patches (Myers & Ewel 1990). *Agalinis flexicaulis* does not seem to tolerate the xeric conditions of other species of *Agalinis* in the area, such as *A. divaricata*, *A. filifolia*, *A. laxa*, and *A. plukenetii*. The author encountered all of these species on several occasions and found no *A. flexicaulis* co-occurring with them. Although *A. flexicaulis* can tolerate drier soils, it demonstrates an affinity for hydric soils, as indicated by the most common associates found growing with it (Table 1). This list is by no means comprehensive, but provides a indicator of commonly encountered species of a hydric (but not saturated), wiregrass-dominated ecotone in northeast Florida. The following wetland status for species found in Gilbert, Tobe, Cantrell, Sweeley, et al. (1995) is utilized: UPL for upland-listed species, FAC for a facultative-listed species, FACW for facultative-wet species, and OBL for obligate-wet plant species.

Agalinis flexicaulis is almost certainly a denizen of moist ecotones in wiregrass-dominated areas: savannas, prairies, seepage slopes, depressional wetlands, or along the upper margins of bogs. More surveys need to be conducted for this new species to form a baseline for its range and target habitat. Unfortunately, most of the wiregrass prairie and longleaf pine savannas in this area (and throughout their range for that matter) are now developed or are in longleaf pine plantations. As long as longleaf pine plantations occur, however, this species should persist if ecologically sound forestry practices are incorporated within management plans, and a "No Mowing" zone were to be implemented by various departments of transportation where the species is known to occur in Bradford County.

In addition, staff of herbaria with Florida holdings of *Agalinis* from Bradford and surrounding counties should re-examine their holdings. This, along with further fieldwork, will allow an assessment of the rarity of *A. flexicaulis*. The author has studied *Agalinis* for over 12 years in Florida alone and was more than surprised at his "discovery" within a well known botanical area less than 20 miles from the University of Florida in Gainesville. This emphasizes not only the need for an additional survey for *Agalinis flexicaulis*, but underscores the fact that there are additional plant species to be described within the remaining intricate natural communities found in Florida.

Below is a key to the long-pediceled species of *Agalinis* to aid in identification.

KEY TO THE LONG-PEDICELED SPECIES OF *AGALINIS* IN NORTHEAST FLORIDA

1. Leaves alternate, reddish-purple, strongly fascicled and appearing whorled, succulent; plants of xeric habitats ____ **A. filifolia**
1. Leaves opposite (sometimes sub-opposite on the flowering branches), green to stramineous, fascicles absent or rarely developed; plants of various habitats.
    2. Plants perennial from a slender root stock, up 1.5 m tall; stems glabrous, often leaning; leaves and pedicels strongly ascending; plants of saturated or inundated soils; dried plants turning black ____ **A. linifolia**
    2. Plants annual, roots fibrous; the stems less than 1 m tall; leaves and pedicels various; plants of xeric to wet soils (but not in permanent bodies of water); plants drying stramineous to dark green, but not drying black.
        3. Stems strongly 4-angled, winged along principal stems; leaves linear to linear-spatulate, 0.6–2.5 cm long, 0.5–1.5 mm wide.
            4. Main stem erect, the branches stiffly ascending, puberulent to scabrous throughout; stems stramineous, drying the same; leaves 1–2.5 cm long, 0.5–1.5 mm wide, erect-ascending; corolla 12–17 mm long, pink, with two yellow guidelines present (sometimes faint), with purple spots in the throat; capsule globose, rounded at summit, surface smooth at apex ____ **A. obtusifolia**
            4. Main stem weakly ascending, glabrous-puberulent, the lowermost branches long-decumbent, laying upon or growing within surrounding vegetation, the secondary branches up to 5 dm in length; stems green, suffused with purplish-maroon, drying green to purplish-green; leaves 0.7–1.3cm long, 0.8 to 1.4 mm wide, spreading; corolla 8–11 mm long, rose-purple, yellow guidelines absent, occasionally with purplish spots in the throat; capsule obovoid to oblong, the apex truncate at summit, with distinctively raised veins on the calyx and capsule, giving the appearance of small tubercles ____ **A. flexicaulis**
        3. Stems sub-terete to striate-angled, not clearly 4-angled; leaves filiform, linear, or narrowly lanceolate, 0.6–3.5cm long, 0.5–3.5 mm wide.
            5. Two upper lobes of the corolla flattened or arched over the stamens; corolla glabrous within; pedicels 10–30 mm long at anthesis, at least some of the pedicels abruptly upturned at the apex, even more noticeable when dried.
                6. Leaves ascending-spreading, 1–4 mm wide, linear to narrowly lanceolate; two upper lobes of the corolla arching over the stamens, about equaling the lower lobes in length; corolla glabrous externally; bracts approaching or equaling pedicels in length; plants erect, often profusely branched, appearing bushy, to 8 dm tall ____ **A. tenuifolia**
                6. Leaves widely spreading, horizontal to the stem, or slightly reflexed at mid-stem, filiform, 0.5–1.0 mm wide; two upper lobes of the corolla flattened over the stamens, half as long as the three lower lobes; bracts much shorter than pedicels; plants sprawling, widely branched, rarely over 3 dm tall ____ **A. divaricata**
            5. Two upper lobes of the corolla reflexed; corolla pubescent within across the bases of the two upper lobes; pedicels 3–30 mm long at anthesis, not abruptly upturned at the apex.
                7. Corolla 14–18 mm long, pedicels on well-developed flowering branches 20–40 mm long, slender, pedicels 3–4 times as long as the subtending bracts ____ **A. laxa**
                7. Corolla 20–30 mm long, pedicels on well-developed flowering branches 4–12 mm long, pedicels stout, equaling or (usually) shorter than subtending bracts ____ **A. plukenetii**

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A NEW *LOMATIUM* (APIACEAE)
FROM THE OCHOCO MOUNTAINS OF CENTRAL OREGON

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ABSTRACT

Lomatium ochocense, a low acaulescent species with a tuberous taproot, is described from the Ochoco Mountains of Crook County, Oregon. The new species differs from the other tuberous *Lomatium* species in its thick, glaucous foliage with broad, overlapping oval to ovate leaflets. This species appears to be a rare local endemic. Habitat differences and phenology of sympatric congeners are discussed.

RESUMEN

Lomatium ochocense, una especie acaulescente con un rizoma tuberoso, se describe las montañas Ochoco del condado de Crook, Oregon. La nueva especie se diferencia de otras especies tuberosas de *Lomatium* por su follaje grueso, glauco con foliolos anchos, de oval a ovados que se solapan. Esta especie parece ser un endemismo local raro. Se discuten las diferencias de hábitat y fenología de congéneres simpátricos.

INTRODUCTION

A new species of *Lomatium* Raf. with decidedly thick glaucous foliage and broad overlapping oval to ovate leaflets was discovered in 1994 on the Ochoco National Forest in the Ochoco Mountains of Crook County in north-central Oregon. The initial site consisted of approximately 200 plants but since then six additional, much larger, populations have been documented on nearby Bureau of Land Management administered land. All known populations are within eleven air kilometers of each other in an isolated area that is difficult to access in early spring when the plants are in flower due to persistent snowdrifts in the canyon bottoms.

Lomatium ochocense Helliwell & Constance ex Helliwell, sp. nov. (**Fig. 1**). TYPE: UNITED STATES. OREGON. Crook Co.: Long Ridge, Ochoco Mountains, T16S, R21E, S11NE1/4, 4540 ft (1360 m), 7 Apr 1995, *Richard Helliwell 2313* (HOLOTYPE: UC; ISOTYPES: NY, OSC, UTC, WS).

Herba perennis humilis acaulescens, glabra et glauca, caule subterraneo (pseudoscapo); radix ovoidea-globosa irregulariter, pagina furva; foliis pinnatis, crassis valde, glaucis et caeruleus; foliolis congestis imbricatis; foliolis infimis par saepe remotis; flores citrine.

Low, acaulescent, glabrous and glaucous perennial herbs, 4–8 cm tall, with a prominent pseudoscape 2–6 cm long. Roots irregularly ovoid-globose, 1–3 cm in diameter, black. Leaves usually 2–5 (the outermost usually much reduced), ascending, pinnate, oblong-oval to triangular-ovate, 1–6.5 cm long, 0.6–2.5 cm broad; petioles up to 3 cm long, abruptly and narrowly sheathing basally; leaflets pinnate or pinnatifid, 3 or 5 (–7), overlapping, oblong to ovate, fleshy, glaucous and blue-green, glabrous, lower-most pair often remote and 3 terminal ones ± confluent basally, lobes oblong to ovate, acute to rounded apically. Inflorescence compact compound umbels; peduncles 1–2, 4–6 cm long, spreading horizontally; involucre 0; rays 2–6, unequal, spreading; fertile pedicels 1–6, 5–10 mm long. Umbellets 10–15-flowered; mature pedicels ca 4 mm long; involucel dimidiate; bractlets ca 8, lanceolate to ovate, 2.5–3 mm long, 0.6–1 mm broad. Flowers perfect, andromonoecious; sepals triangular-lanceolate, green, 0.1–0.2 mm long or absent; petals yellow, oval-ovate, abruptly acuminate, 1–2 mm long; stamens maturing unequally, filaments terete, 0.2–1.7 mm long, anthers yellow, turning white, 0.4–0.7 mm long; styles 0.8–1.2 mm long, glabrous, yellowish-green; ovary glabrous, green. Fruit elliptic, 5–8 mm long, 3.5–4.5 mm broad, glabrous; dorsal ribs filiform, lateral ribs narrowly thin-winged, narrower than the body; vitae small, 2–3 in intervals, usually 4 on commisure; seed face nearly plane.

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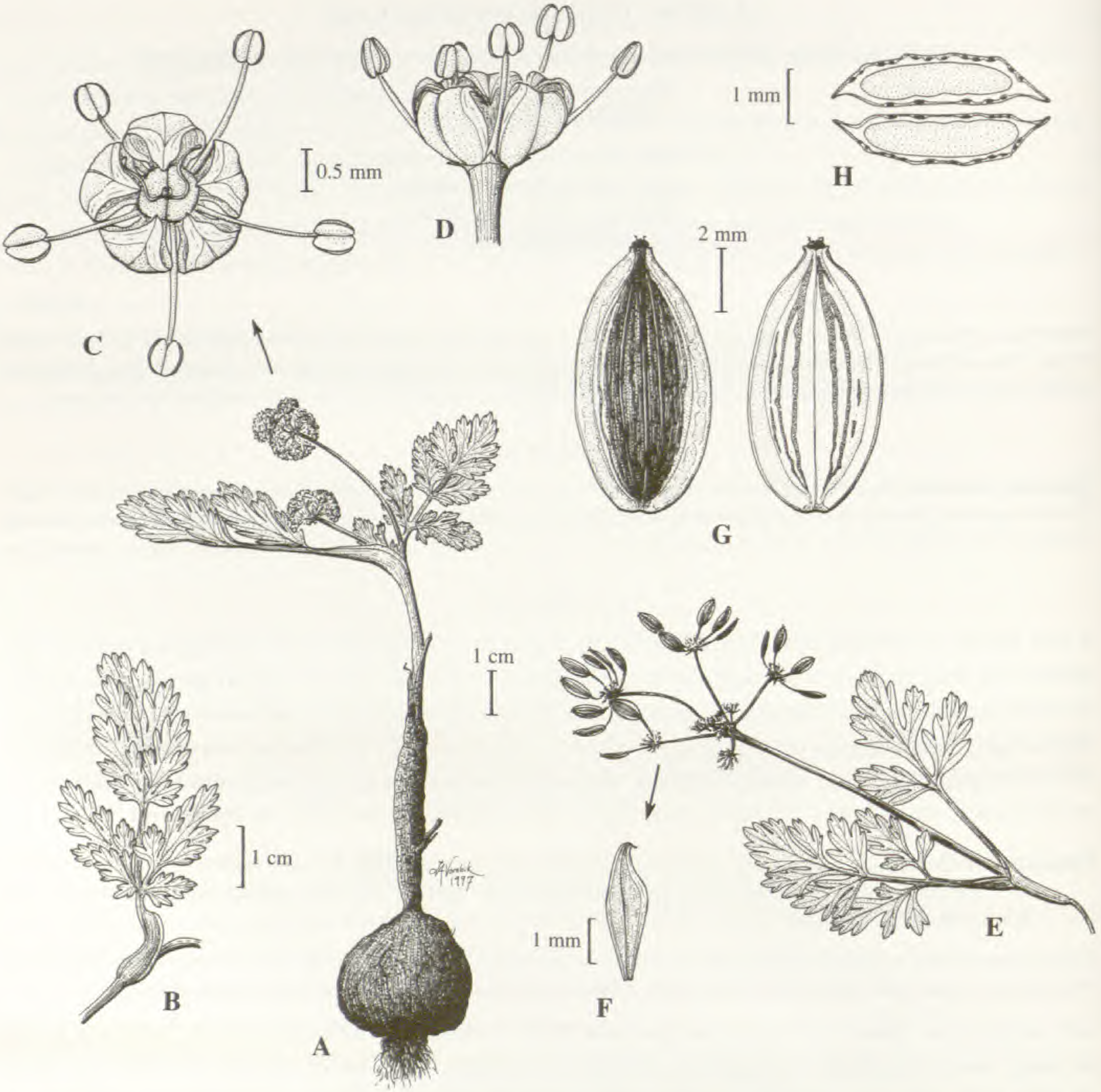

Fig. 1. ***Lomatium ochocense*****. a. Habit in flower. b. Leaf. c. Perfect flower. d. Staminate flower. e. Habit in fruit. f. Involucel bract. g. Schizocarp (mericarp), dorsal and ventral view. h. Fruit cross-section.**

Other specimens seen: **UNITED STATES. Oregon. Crook Co.:** Upper Falls, T15S, R22E, S17, 1350 m, 26 May 94, *Helliwell 2304, 2306* (UC).

Relationship.—The massively thickened root of *Lomatium ochocense* clearly places it within the tuberous group of lomatium, an informal group initially recognized by Coulter and Rose (1888), retained by Marcus E. Jones (1908) as sect. *Cous* and most recently monographed by Schlessman (1984). Subsequent genetic work by Solstis and Novak (1997) have determined this group to be polyphyletic having evolved from at least four lineages. Although *L. ochocense* is nearly as diverse genetically as the common *L. cous* (S. Watson) J.M. Coult. & Rose and *L. macrocarpum* (Nutt. ex Torr. & A. Gray) J.M. Coult. & Rose (Gitzendanner & Soltis 2001), its phylogenetic relationships within the genus remain to be determined. Although not monophyletic, this remains a useful artificial group within this large and diverse genus since the tuberous roots appear to represent a case of parallel evolution in response to the thin, rocky soils and xeric environment that these species share.

Lomatium ochocense is readily distinguishable from congeners by its thick, glaucous, overlapping leaflets that are glaucous blue-green. Among non-tuberous species, superficial similarity to *L. greenmanii* Mathias has been noted. This subalpine endemic of the Wallowa Mountains in northeast Oregon also has pale, glaucous foliage however it is distinctly caulescent, has mostly remote leaflets, and arises from a multicipital, woody caudex.

DISTRIBUTION, ECOLOGY, AND PHENOLOGY

Lomatium ochocense appears to be a restricted endemic. Populations are confined to shallow residual soils on lava tablelands known locally as "scablands". These scablands are dissected by deep V-shaped canyons that are timbered with *Pinus ponderosa* P. Lawson & C. Lawson and *Pseudotsuga menziesii* (Mirb.) Franco with *Juniperus occidentalis* Hook. abundant along the margins of timber and scattered sporadically across the scabland wherever fracturing in the basalt or lenses of deeper soil allow it. Soils on the scablands are classified as loamy-skeletal, mixed, superactive, frigid Lithic Argixerolls in the Tweener Series http://www2.ftw.nrcs.usda.gov/osd/dat/T/TWEENER.html. Bedrock is hard, highly fractured basalt of the Picture Gorge formation of the Columbia River group (Baldwin 1964). *Lomatium ochocense* is restricted to areas where there is exposed bedrock. The climate is characterized by cold moist winters and warm dry summers. Soils are typically saturated through the winter but dry out rapidly by late spring. Elevations of known populations are between 1300 and 1400 m.

Lomatium ochocense occurs in plant communities dominated by *Artemisia rigida* (Nutt.) A. Gray and *Poa secunda* J. Presl. Other associates include *Allium macrum* S. Watson, *Lewisia rediviva* Pursh, *Lomatium cous*, *Lomatium hendersonii* (J.M. Coult. & Rose) J.M. Coult. & Rose, *Lomatium macrocarpum*, *Achnatherum hendersonii* (Vasey) Barkworth, and *Sedum stenopetalum* Pursh. The *Lomatium* species provide the most conspicuous cover across these scablands in early spring with *L. ochocense* flowering from mid-March to late April.

In addition to *Lomatium cous*, *L. hendersonii*, and *L. macrocarpum*, all of which can be found within 20 cm of *L. ochocense*, there are at least eight other species of *Lomatium* in the immediate vicinity. Similar cases of congeners growing together in close proximity have been called "genus communities" (Diver 1936). The ability of similar species to coexist in nearly identical habitats without apparent production of hybrids affords testimony to their reproductive isolation. *Lomatium ochocense*, *L. cous*, and *L. hendersonii* are united by their massive corm-like roots, low acaulescent habit, and yellow flowers but clearly maintain their distinguishing characters in sympatric populations without apparent introgression.

Across these open scablands the *Lomatium* species have segregated themselves by often subtle microsite characteristics. *Lomatium cous* is the most common of the species. It is present on every scabland opening and, together with *L. macrocarpum*, seems to have the least specific habitat requirements. Nevertheless, despite considerable overlap, these two species exhibit significant spatial segregation. In sympatric populations in this area, *L. cous* usually dominates the broad tops of these tablelands while *L. macrocarpum* occupies the gently sloping sides. *Lomatium ochocense* displaces *L. cous* in many areas where there is exposed bedrock in the form of parallel ripples although other areas of apparently identical habitat in the vicinity lack *L. ochocense*. This rock feature appears to be unique to the narrow range of *L. ochocense* and is strikingly evident on aerial photographs. The soil depth where *L. ochocense* occurs is typically 5–9 cm with the root seated in fractures at the bedrock/soil interface. *Lomatium hendersonii* is largely confined to narrow bands of unconsolidated rock called "rock stripes" that commonly lie in parallel formation across the top or side of scablands. In many cases the root is seated in a substrate of loose rock with little or no soil.

Three other *Lomatium* species were observed sharing scabland habitat in the immediate vicinity although they were not intermingled with *L. ochocense*. In slightly deeper or less rocky soil *L. piperi* J.M. Coult. & Rose occurs and in slightly moister areas, particularly those with depressional microrelief, *L. leptocarpum* (Torr. & A. Gray) J.M. Coult & Rose replaces the other *Lomatium* species. A short-statured ecotype of *L.*

nudicaule (Pursh) J.M. Coult. & Rose is present in slightly deeper soil around the perimeter of the habitat for *L. ochocense*.

Additional *Lomatium* species that were noted in other than scabland habitat in the vicinity include *L. grayi* (J.M. Coult. & Rose) J.M. Coult. & Rose on vertical rock outcrops; *L. dissectum* (Nutt. & Torr. & A. Gray) Mathias & Constance in talus; *L. triternatum* (Pursh) J.M. Coult. & Rose under a timbered canopy; *L. vaginatum* J.M. Coult. & Rose in an inclusion of heavy red soil; and *L. donnellii* (J.M. Coult. & Rose) J.M. Coult. & Rose in deeper, disturbed soils.

The scabland *Lomatium* species are also slightly separated by phenology although all flower early. *Lomatium hendersonii* and *L. piperi* flower by mid-February and perhaps even earlier. *Lomatium cous* appears to slightly precede *L. ochocense* but both were in flower by the second week of March in 1995. *Lomatium macrocarpum* and *L. leptocarpum* began flowering by early April in 1995 leaving only *L. nudicaule* yet to flower. Note that these dates differ significantly from published dates in regional floras (e.g., Cronquist 1961).

It is notable that thickening of the taproot is a consistent feature of the species that are confined to open lithosols. *Lomatium ochocense*, *L. cous*, and *L. hendersonii* all have large irregularly shaped tuberous taproots. *Lomatium piperi* has a globose taproot while *L. leptocarupum* and, to a lesser extent, *L. macrocarpum* both have tuberous thickenings unevenly distributed along their taproot. *Lomatium nudicaule*, which is more commonly found on deeper soils throughout its range, has a stout evenly thickened taproot. The other species have roots that are much less thickened.

Etymology.—For the Ochoco Mountains.

Conservation status.—Although *Lomatium ochocense* appears to be a narrow endemic, the bulk of the known populations lie within a BLM wilderness study area, population sizes are mostly very large, and the potential threats to this species are few. One occurrence is adjacent to a popular recreation area but the rocky nature of the habitat minimizes the potential for adverse impacts from recreationalists. The entire area lies within cattle grazing allotments but the specific areas where *L. ochocense* grow receive insignificant livestock use due to the inherently sparse forage. Several plants were observed to have been browsed, apparently by mule deer that browse the scablands in early spring. Although the species had not yet been validly published, the U.S. Fish and Wildlife Service formally proposed that *L. ochocense* be considered a "species of concern" to ensure its long-term management in August of 2009. Likewise, the plant is considered an "imperiled plant" by the Forest Service (http://www.fs.fed.us/wildflowers/rareplants/profiles/critically_imperiled/lomatium_ochocense/index.shtml), and the name is found on the USDA PLANTS database (http://plants.usda.gov/java/profile?symbol=LOOC2).

Comments.—It should be noted that the name *Lomatium ochocense* was first proposed in 1995 soon after the species was discovered. With the assistance of the late Lincoln Constance (1909–2001) a manuscript was prepared and state and federal agencies notified of this rare species. Over the intervening years *L. ochocense* has been the subject of genetic research resulting in the name being published, without description or designation of type, as a *nomen nudum* in Gitzendanner and Soltis (2001). The scientific name proposed by Constance and myself, the detailed description, and the authorship of the name is retained in recognition of Dr. Constance contribution to this effort. However, as he cannot defend the text, I assume responsibility for that.

KEY TO THE TUBEROUS SPECIES OF *LOMATIUM* IN OREGON

1. Leaves thick, glaucous, blue-green, glabrous; leaflets broadly overlapping, oval-ovate ________ **L. ochocense**
1. Leaves often glabrous but never also thick, glaucous and blue-green, leaflets typically remote except sometimes distally, variously shaped.
   2. Petals white, anthers and stylepodia purple.
      3. Mericarps minutely granular-roughened or bristly, the papillae 0.05 mm long, visible at 15x; acaulescent ________ **L. gormanii**
      3. Mericarps glabrous; sometimes with a reduced cauline leaf.
         4. Longest pedicels (4–)5–15 mm long at maturity; roots globose, up to 5 cm in diameter with a slight kerosene-like odor ________ **L. canbyi**

4. Longest pedicels 0.5–3 mm long at maturity; roots globose, rarely more than 1.5 cm in diameter, odorless **L. piperi**

2. Petal, anthers and stylepodia yellow.

5. Involucel wanting **L. ambiguum**

5. Involucel present.

6. Involucral bractlets fused ¼–½ their length or sometimes nearly to the apex, usually dimidiate **L. watsonii**

6. Involucral bractlets not fused, sometimes dimidiate

7. Involucral bractlets narrowly to broadly obovate, 0.8–3.2 mm wide; pedicels 1–3 mm long at maturity **L. cous**

7. Involucral bractlets linear to elliptic, up to 1.0 mm wide; pedicels 1–24 mm long at maturity.

8. Cauline leaves present, irregularly pinnately divided; herbage puberulent; Snake River Canyon endemic **L. rollinsii**

8. Plants acaulescent or nearly so, regularly pinnately divided; herbage glabrous; not endemic to the Snake River Canyon.

9. Mericarps linear (6–)9–17 mm long; pedicels short 1–3 mm **L. leptocarpum**

9. Mericarps elliptic to ovate < 9 mm long; pedicels longer, 2.5–24 mm.

10. Roots globose; leaves ternately compound with long, narrow ultimate segments 1–10 cm long and 0.5–3 mm wide **L. hambleniae**

10. Roots not perfectly globose; leaflets not so long and narrow < 2.5 mm.

11. Plants acaulescent; peduncles short at maturity, about 1 dm long and curved to the ground **L. hendersonii**

11. Plants weakly caulescent; peduncles usually more than 1 dm, spreading to erect **L. roseanum**

ACKNOWLEDGMENTS

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BOOK REVIEW

Stewart McPherson. 2008. **Glistening Carnivores: The Sticky-Leaved Insect-Eating Plants.** (ISBN 978-0-9558918-1-6, hbk.). Redfern Natural History Productions, 61 Lake Drive, Hamworthy, Poole, Dorset BH15 4LR, England, United Kingdom. (**Orders:** www.redfernnaturalhistory.com, sales@redfernnaturalhistory.com, +44-1202-686585). £29.99 (US $46.15), 392 pp., 271 color photos, 1 b&w figure, 7 maps, 6 1/4" × 9 1/4".

Amongst a sea of other botanical publications, *Glistening Carnivores* stands out to me as a very interesting read. With a large (and very artistic, I might add), high-quality image on nearly every page, it is hard to pull your nose out of this book. The layout of the text is a detailed walk through the many varieties of carnivorous plants with each genus and species discussed in great detail. McPherson outlines nearly every aspect of this intriguing field and provides the reader with a solid foundation. I would recommend this book to anyone who has an interest in learning more about the world of carnivorous plants.—*Haden Shibley, Volunteer, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

From the publisher: "The seven genera of sticky-leaved insect-eating plants are uniquely beautiful and captivate the interest of all who behold them. Each produces shimmering leaves lined with glistening droplets of glue that attract, trap and kill insects and other small animals. This work examines all seven genera of sticky-leaved insect eating plants (*Byblis, Drosera, Drosophyllum, Ibicella, Pinguicula, Roridula* and *Triphyophyllum*) and documents their wild ecology and natural diversity in full detail and in many cases, for the very first time…"

"**Stewart McPherson** is a British geographer who has studied at the University of Durham in England, the University of Tuebingen in Germany, and Yale University in the United States. Fascinated with the sticky-leaved insect-eating plants from an early age, he prepared this work as an overview of the diversity, wild ecology and beauty of this fascinating group of plants… *Glistening Carnivores* is the product of four years of research and travel and is his third book."

POTENTILLA ULIGINOSA (ROSACEAE: ROSOIDEAE), A NEW PRESUMED EXTINCT SPECIES FROM SONOMA COUNTY, CALIFORNIA

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ABSTRACT

Potentilla uliginosa is proposed for a localized endemic, presumed extinct, formerly known from the oligotrophic Cunningham Marsh near Cunningham in Sonoma County, California. The new species belongs to a morphologically and ecogeographically defined species cluster in sect. *Multijugae* (Rydb.) A. Nelson that also includes *P. hickmanii* Eastwood, *P. millefolia* Rydb., *P. multijuga* Lehm., and *P. plattensis* Nutt. It differs from the two other species of coastal California, *P. multijuga* (also presumed extinct) and *P. hickmanii* (federally and state endangered) in its more deeply incised leaflets (70–90% to midrib in *P. uliginosa*, vs. 30–40% in *P. multijuga* and 50–65% in *P. hickmanii*), and additionally from the latter in longer stems (2.5–5.5 vs. 0.5–2.5 dm) and leaves (15–32 vs. 3–17 cm), and leaflets that are irregularly pinnately divided rather than palmately divided or flabelliform.

RESUMEN

Se propone **Potentilla uliginosa** para un endemismo localizado, presumiblemente extinto, conocido previamente de la oligotrófica Cunningham Marsh cerca de Cunningham en el condado de Sonoma, California. La nueva especie pertenece a un grupo de especies definidas morfológica y ecogeográficamente de la sect. *Multijugae* (Rydb.) A. Nelson que también incluye *P. hickmanii* Eastwood, *P. millefolia* Rydb., *P. multijuga* Lehm., y *P. plattensis* Nutt. Difiere de las otras dos especies de la costa de California, *P. multijuga* (también presumiblemente extinta) y *P. hickmanii* (en peligro a nivel federal y estatal) por sus foliolos más profundamente incisos (70–90% del nervio central en *P. uliginosa*, vs. 30–40% en *P. multijuga* y 50–65% en *P. hickmanii*), y además, de esta última por sus tallos más largos (2.5–5.5 vs. 0.5–2.5 dm) y hojas (15–32 vs. 3–17 cm), y foliolos que son irregularmente pinnados en vez de palmados o flabeliformes.

Key Words: Rosaceae, Potentilla, Cunningham Marsh, California, new species, conservation, extinct species

In 1946 and 1947, Milo S. Baker and John Thomas Howell evidently made joint collecting trips to an area referred to in Baker's field book as "Joe Cunningham Marsh Campground," near the town of Cunningham in Sonoma County, California. Among the plants they collected was a *Potentilla*, possibly representing the same population as a collection by Joseph W. Congdon from "Sebastopol to Stony Point Road, Analy Township" in 1880 (GH, MIN). Baker and Howell identified the *Potentilla* as *P. hickmanii* Eastwood, which had otherwise been known only from two stations in Monterey and San Mateo counties (Jepson 1936). This identification was adopted in subsequent state and regional floras (e.g., Best et al. 1996; Munz 1959; Rubtzoff 1953).

While revising *Potentilla* sect. *Multijugae* (Rydb.) A. Nelson as his doctoral thesis (Johnston 1980), incorporating numerical analyses of twenty morphological characters, the senior author concluded that the Sonoma County population was distinct from populations of *P. hickmanii* in Monterey and San Mateo counties. The Sonoma County population differed in having longer stems (2.5–5.5 vs. 0.5–2.5 dm) and leaves (15–32 vs. 3–17 cm), and leaflets that were irregularly pinnately divided (rather than palmately divided or flabelliform). Instead, he found the closest morphological comparison to *P. plattensis* Nutt., a species with regularly pinnately divided leaflets occurring in wet meadows and sloughs from the plains of Alberta and Manitoba sporadically south to the southern Rocky Mountains in northern New Mexico and Arizona. He also noted similarities to *P. multijuga* Lehm., an apparently extinct species from southern California with comparable habitat, habit, and stature but with fewer (7–17 vs. 17–21[–25]) and much more shallowly divided leaflets (30–40% vs. 70–90%). In his thesis (Johnston 1980), the senior author described the Sonoma County plants as a new species (*P. uliginosa*), but he annotated the specimens as a new variety of *P. hickmanii*. For various reasons, however, formal publication at either species or varietal rank was postponed.

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In 1987, the junior author tried to relocate the ambiguous *Potentilla* in Cunningham Marsh, without success. As a result, she retained the plants within *P. hickmanii* in her revision of the genus for California (Ertter 1993a), albeit with the note "may warrant recognition." She also discussed the taxonomic quandary in an overview of the species complex (Ertter 1993b). In the process of preparing updated treatments for California and *Flora of North America North of Mexico,* however, she decided that the distinctions between the Cunningham Marsh plants and *P. hickmanii* s.s. were too significant to overlook. Formal publication of the Sonoma County population is accordingly presented here.

Potentilla uliginosa B.C. Johnston & Ertter, sp. nov. (**Fig. 1**). TYPE: U.S.A. CALIFORNIA. Sonoma Co.: ca. 1 mi (airline) SW of Cunningham Station in Cunningham Marsh, 26 Jun 1947, *Milo S. Baker 11831* (HOLOTYPE: UC 963929; ISOTYPES: CAS, RSA, UC 972187 [erroneously written as *10831*, which is a collection of *Crepis* according to Baker's field notes]).

Planta perennis elata caulibus erectis 25–55 cm longis, e caudice crasso verticali non ramoso plerumque unicipiti fuscis stipularum petiolorumque emortuarum dense vestito, in aspecto plerumque stramentosa. Caules petiolaque graciles, incavi, ferruginei, glabrati vel obscure sparseque strigosi. Folia radicalia erecti, rhachide 21–25(–29) cm longa, folioliis 17–21(–25) verticillatis pinnatis, 40–60% rhachidis occupantis. Foliolum terminale pinnatim profunde in segmenta longa angusto-lanceolata divisum. Foliola demissiora similiter pinnatim divisa; foliola demississima palmatim divisescentes; omnes foliolorum segmentis 7–10 angusto-lanceolatis 70–90% ad costam incisi, sparse ad uniformiter utrinque strigosi sed obscure, in aspecto virides glabrescentesque. Caules, stipulis medicaulinis 11–16 mm longis 4–5 mm latis plerumque divisis, floribus 6–10 in pedicellis recurvatis tempore fructificantis. Calyx 9 mm altus (lobis inclusis), moderate vel dense strigosus, lobis lanceolatis brevi-acuminatis, bracteolis ovatis lobis 0.7–1.0–plo longioribus. Stamina 20, antheris 0.7–0.9 mm longis in filamentis 1.5–2.8 mm longis. Pistilla ca. 20; stylis 2.7–3.6 mm longis, filiformibus, e basi leviter angustatis, stigmatibus conspicuis papillosis rubiginosis capitatis. Achaenia 2.0–2.6 mm longa, viridula, laevia. Habitat solum in paludo uliginosa maritima prope Cunningham in California.

Stems 2.5–5.5 dm tall, from a thick vertical unbranched rootstock, the usually solitary root-crown covered with the dark red-brown remains of previous seasons' stipules, which often remain attached to their petioles, giving the caudex a thatched look; stems and petioles thin, reddish-brown, glabrous to sparsely and obscurely strigose. **Basal leaves** pinnate, 15–32 cm long, 2–4 cm wide: rachis 21–25(–29) cm long; leaflets (13–)17–21(–25), irregularly paired, somewhat verticillate, occupying 40–60% of the rachis; largest leaflets cuneate to flabellate, 1.2–2.2 cm long, distal leaflets ± pinnately or irregularly divided, proximal leaflets ± palmately divided, into (3–)7–10(–15) narrowly oblanceolate to linear segments cutting 70–90% to midrib, sparsely to uniformly strigose on both surfaces but always obscurely so, appearing green and glabrescent to the naked eye; terminal leaflet indistinct, lobed and/or confluent with adjacent lateral leaflets. **Cauline leaves** 2; stipules 11–16 mm long and 4–5 mm wide, usually divided. **Inflorescences** open, 6–10-flowered; pedicels 1–6 cm long, recurved in fruit. **Flowers:** calyx 9 mm high (including sepalar lobes), moderately to densely strigose; epicalyx bractlets ± lanceolate, 4–6 mm long, 1–2.5 mm wide, 0.7 as long as the sepalar lobes or longer; sepalar lobes ovate, 4–7 mm, acute; petals 6–10 mm long, 5–8 mm wide, bright yellow; stamens 20, filaments filiform, (1.5–)2–2.8 mm long, anthers 0.7–0.9(–1.2) mm long; pistils ± 10–20, styles 2.7–3.6 mm long, filiform and very slightly tapered from the base, stigma capitate, conspicuously papillose, red-brown. **Achenes** 2.0–2.6 mm long, light-green, smooth, ± carunculate.

Ecology, phenology, and status.—Permanent oligotrophic wetlands, 30–40 m elev. Flowering May to August. Presumed extinct.

Etymology and vernacular name.—From Latin *uliginosus*, marshy, in reference to the habitat. Cunningham Marsh cinquefoil is the obvious vernacular name.

Conservation status.—*Potentilla uliginosa* is apparently known from only three collecting events, all possibly from the same site: by Congdon in 1880 and by Baker and Howell in 1946 and 1947. Baker's field notes augment the specimen label data: "Cunningham Marsh within the fence of the Campground about 1.5 mi west of town of Cunningham on ranch owned by Mr. Voight." Although a cinquefoil identified as *P. hickmanii* was noted on a 1990 survey of the Cunningham Marsh conservation easement site (Baye 2005), no voucher is known. Subsequent surveys failed to confirm the species' continued existence (Baye 2005), and the plant (as *P. hickmanii*) is accordingly noted as "Presumed extinct in the county" in the Sonoma County flora (Best et al. 1996). A conservation plan is nevertheless proposed by Baye (2005) for "*Potentilla*

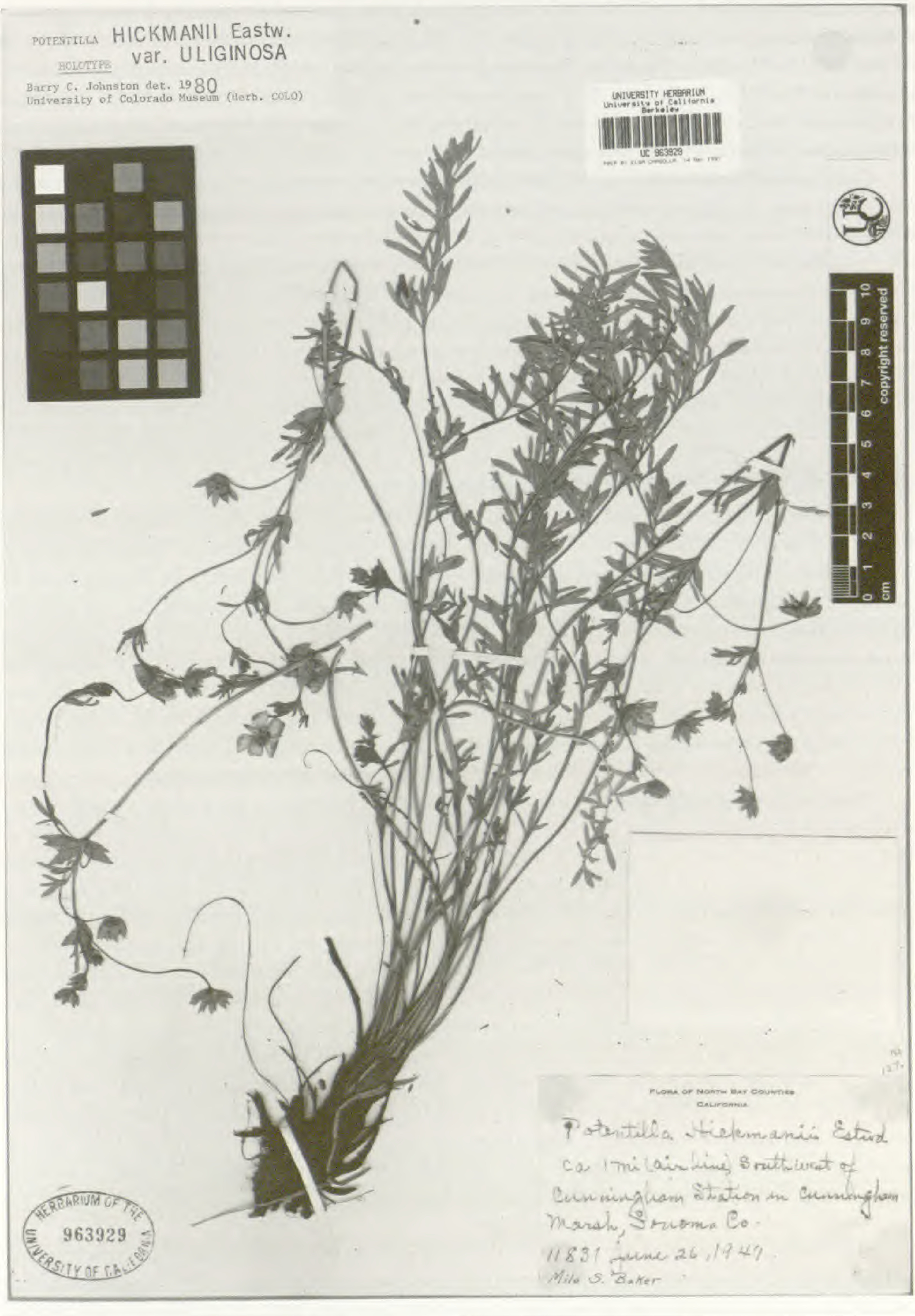
POTENTILLA HICKMANII Eastw.
HOLOTYPE var. ULIGINOSA
Barry C. Johnston det. 1980
University of Colorado Museum (Herb. COLO)
UNIVERSITY HERBARIUM
University of California
Berkeley
UC 963929
0 1 2 3 4 5 6 7 8 9 10 cm
copyright reserved
FLORA OF NORTH BAY COUNTIES
CALIFORNIA
Potentilla Hickmanii Eastw.
ca 1 mi (air line) Southwest of
Cunningham Station in Cunningham
Marsh, Sonoma Co.
11831 June 26, 1947.
Milo S. Baker
HERBARIUM OF THE
963929
UNIVERSITY OF CALIFORNIA

Fig. 1. Holotype specimen of *Potentilla uliginosa*, University Herbarium, University of California at Berkeley (UC 963929).

sp. (nominal *P. hickmanii*)," in the event that living plants are rediscovered or "recruited from a (hopefully) dormant persistent seed bank." It is also possible that additional populations remain to be discovered in the mountains of northwestern California. Tantalizing in this regard is a 1929 collection (*Applegate 5735*, UC) identified as *P. millefolia* Rydb. from Deer Creek near Selma, Josephine County, Oregon, which approaches *P. uliginosa* in stature and occurs outside the otherwise known range of *P. millefolia* (i. e., meadows from south-central Oregon to the east side of the Sierra Nevada in California and Nevada).

Cunningham Marsh itself is one of three perennial wetland complexes in southern Sonoma County that share a suite of disjunct, endemic, and regionally rare wetland species (Baye 2005; Best et al. 1996; Rubtzoff 1953), the other two being Pitkin Marsh and the lesser known Perry Marsh. All three are relatively oligotrophic (acidic and nutrient-poor) with permanent fen-like water systems (Baye 2005). As such, they harbor numerous disjunct species more characteristic of northern bog-like habitats, leading Rubtzoff (1953) to interpret the marshes as relictual floristic "islands." The main "poster-child" plant is the federally endangered Pitkin Marsh lily (*Lilium pardalinum* Kellogg subsp. *pitkinense* (Beane & Vollmer) M.W. Skinner), which is endemic to Pitkin and Cunningham marshes. While more conservation attention has been paid to Pitkin Marsh, which has the largest number of significant species, a conservation easement was established in Cunningham Marsh in 1998, in response to a proposed subdivision on adjacent lands (Baye 2005). Whether the easement site includes the historical locality of *P. uliginosa*, or whether that locality has already been converted to agricultural uses or subdivisions, has yet to be determined.

Plant species that are presumed extinct are more commonly described in the paleobotanical literature, and the unavailability of living or recently collected material of *Potentilla uliginosa* has hampered the kind of studies (e.g., molecular analysis, common garden experiments) that would otherwise be appropriate for taxonomic recognition of morphologically anomalous plants known from single populations. The morphological anomalies are nevertheless sufficient in their own right to justify recognition of the Cunningham Marsh cinquefoil as a distinct species. This action clarifies conservation efforts not only of *P. uliginosa* but also *P. hickmanii*, which is endangered under both federal regulations (Clark 1998) and California state regulations (California 2004). In particular, formal recognition of *P. uliginosa* supports the strong recommendation in the Cunningham Marsh conservation easement area management plan (Baye 2005) against "nominal reintroduction" efforts using *P. hickmanii* from San Mateo or Monterey counties.

Relationships.—*Potentilla uliginosa* is a distinctive species that belongs to a morphologically and ecogeographically defined species cluster in *Potentilla* sect. *Multijugae* that also includes *P. hickmanii*, *P. millefolia*, *P. multijuga*, and *P. plattensis*. As already noted, the new species has heretofore been included within *P. hickmanii*, differing most notably in its larger dimensions (e. g., stems 2.5–5.5 dm vs. 1.5–2.5 dm). The leaflets of *P. uliginosa* are more comparable to those of *P. millefolia* and *P. plattensis* in being divided 70–90% to the midrib into (3–)7–10(–15) narrowly oblanceolate to linear segments (vs. divided only 50–65% to midrib into 2–5 somewhat broader segments in *P. hickmanii*). In contrast to the irregularly pinnate leaflets of *P. uliginosa*, those of *P. millefolia* tend to be palmately lobed, while those of *P. plattensis* are more regularly pinnately lobed, with the terminal leaflet relatively distinct from (vs. confluent with) the lateral leaflets. Plants of *P. uliginosa* tend to be larger (2.5–5.5 dm vs. 0.5–2.5 dm) than either *P. millefolia* or *P. plattensis*, and are rather in the size range of *P. multijuga* (2.0–3.5 dm). *Potentilla multijuga* also differs from *P. uliginosa* in having fewer leaflets (7–17 vs. [13–]17–21[–25]) that are more shallowly incised (only 30–40% to the midrib). Likewise presumed extinct, *P. multijuga* is known only from a handful of collections in the 1890's from Ballona Marsh near the current site of Los Angeles International Airport in Los Angeles County, California. The name *P. multijuga* has been proposed for conservation with a conserved type (Ertter & Reveal 2008), since the original type has proven to be *Horkelia cuneata* Lindl. (Soják 1996).

As previously hypothesized (Ertter 1993b), the species cluster to which *Potentilla uliginosa* belongs has evidently radiated among seasonally or permanently saturated wetlands of western North America, resulting in numerous isolated populations. Some of these populations have speciated into narrow endemics, including species that are federally and state endangered (*P. hickmanii*), candidates for federal listing (*P. basaltica*

Tiehm & Ertter), or presumed extinct (*P. multijuga, P. uliginosa*). Several other anomalous populations may prove distinct upon further analysis, notably an outlier of *P. millefolia* in Reese River Valley in Lander County, Nevada. In our understanding, the recently described *P. diversifolia* Lehm. var. *madsenii* S. L. Welsh & N. D. Atwood, reported from a single collection from Kane County, Utah (Welsh et al. 2008), also belongs to this complex as a variant of *P. plattensis*; it is currently on the "Need Data List" for the Rare Plants of Utah (Utah Native Plant Society Rare Plant Committee 2009). Molecular analyses of the complex are currently underway by Matt Guilliams, a graduate student at the University of California at Berkeley.

Additional collections examined: **U.S.A. California: Sonoma Co.:** Sebastopol and Stony Point Road, Analy Township, 16 May 1880, *J. W. Congdon s.n.* (GH, MIN); Cunningham Marsh within the fence of the "Camp Ground," ca. 1.5 mi W of the town of Cunningham, 17 Aug 1946, *M.S. Baker 11550* (CAS, RSA); Cunningham Marsh ca. 1 mi W of Cunningham, 17 Aug 1946, *J.T. Howell 22861* (CAS, US); Cunningham Marsh, 26 Jun 1947, *J.T. Howell 23297* (CAS, NY).

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TWO NEW TAXA OF *SCUTELLARIA* SECTION *RESINOSA* (LAMIACEAE) FROM NORTHERN ARIZONA

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ABSTRACT

Collections made in Yavapai and Coconino counties, Arizona, previously identified as *Scutellaria potosina*, are here described as new varieties, one in *S. potosina* and the other in *S. platyphylla*. Variety **occidentalis** increases the range of the *S. platyphylla*, a species endemic to central Arizona, northwest to the Upper Verde Watershed. Variety **kaibabensis** brings the total number of varieties of *S. potosina* to nine and represents the northern and western-most populations of that widespread, Chihuahuan desert species.

RESUMEN

Colectas llevadas a cabo en los condados de Yavapai y Coconino, Arizona, previamente identificadas como *Scutellaria potosina*, se describen como variedades nuevas, una en *S. potosina* y la otra en *S. platyphylla*. La variedad **occidentalis** incrementa el rango de *S. platyphylla*, especia endémica de la parte central de Arizona, en dirección noroeste, hacia la cuenca alta del Río Verde. La variedad **kaibabensis** incrementa el número total de variedades de *S. potosina* a nueve, y representa las poblaciones más norteñas y occidentales de esta especie de amplia distribución en el desierto de Chihuahuense.

Key Words: *Scutellaria potosina*, *Scutellaria platyphylla*, Lamiaceae sect. *Resinosa*, SEM, vestiture, mericarps

Scutellaria sect. *Resinosa* Epling is well represented in the southwestern U.S. and throughout northern and central mainland Mexico. Epling (1942) defined sect. *Resinosa* based on the presence of entire, oval or rounded leaves, violet-blue corollas, corolla tube and galea less than 22 mm long, calyx compressed into an erect and transverse scutellum, and subglobose mericarps. Turner's (1994) revision of sect. *Resinosa* provided evidence for a broadly distributed *S. potosina* Brandegee, which occurs from the Sierra Madre Oriental, Mexico north and west to central Arizona. The species was comprised of two subspecies: subsp. *potosina*, a morphologically diverse group of six varieties; and subsp. *platyphylla* Epling, represented by the type variety only. *Scutellaria potosina* was separated from the other 18 species in sect. *Resinosa* by the presence of tessellate mericarps and a pubescence of glandular and eglandular hairs. Turner described four new varieties of *S. potosina* in his treatment of *Scutellaria* sect. *Resinosa* based on differences in habit, leaf morphology, and vestiture. *Scutellaria potosina* var. *platyphylla* was later elevated to specific status by Turner and Delprete (1996) based on mericarp ornamentation, foliage vestiture, and distribution.

Collections made in Yavapai and Coconino counties, Arizona, previously identified as *S. potosina*, appeared to be intermediate between *S. potosina* and *S. platyphylla* (Epling) B.L. Turner & P. Delprete. These collections represent two different entities from four localities on the eastern rim of the Kaibab Plateau in Coconino County and three localities in the Upper Verde River drainage in Yavapai County. Both entities have a distinctive short stature and prolific branching from the root crown not seen in either *S. potosina or S. platyphylla*. However, they appeared to differ significantly in vestiture when viewed under a dissecting microscope.

All of the12 recent collections have been made since 1993 except for one specimen from the Upper Verde watershed collected in 1984 (*Hodgson 2887*, DES). This specimen was not included by Turner in his 1994 taxonomic treatment nor his subsequent morphological studies (Turner & Delprete 1996).

A SEM study was undertaken to visualize micromorphological characters needed to verify the taxonomic rank of the new collections and their placement within sect. *Resinosa*. Leaf vestiture and mericarp size, color, and shape of the two new taxa fit well within the sect. *Resinosa*, but a SEM study was needed to

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visualize individual hair types and papillae on the mericarps, both important species level characteristics in *Scutellaria* (Olmstead 1990; Turner 1996).

The Kaibab Plateau populations are unique in that the leaves lack glandular and eglandular hairs altogether but are densely covered with sessile glands on both the upper and lower surfaces. Leaves of known varieties of *Scutellaria potosina* in the U.S. and northern Mexico also lack glandular hairs but var. *tessellata* (Epling) B.L. Turner has scattered eglandular hairs and a few sessile glands on the upper and lower leaf surfaces, while var. *grahamiana* B.L. Turner is nearly glabrous, with few sessile glands and eglandular hairs. The mericarp surface-sculpturing of the Kaibab Plateau populations is similar morphologically to var. *tessellata*. Both have short flattened papillae with epidermal cells that have conical or domed apices without apical callosities (Fig. 1). The holotype and one topotype of var. *grahamiana* lacked mericarps and none was found during field work conducted in 2000. Var. *grahamiana* may require outcrossing, lack its pollinator, or may possibly represent a sterile hybrid of unknown origin. Based upon field observations and morphological study, including SEM of leaves and mericarps (Table 1), the Kaibab Plateau population is here described as a new variety of *S. potosina*, differing chiefly in habit and a vestiture of sessile glands only.

The Upper Verde populations are densely covered with sessile glands and glandular hairs similar to *S. platyphylla*, although those found on *S. platyphylla* are long, ca. 50 microns, while those on the Upper Verde plants are only ca. 20 microns (Fig. 1, C and D). Mericarp surface sculpturing of the Upper Verde plants also resembles that found in *S. platyphylla* (Turner 1996). Both have short conical papillae that are domed at the apex and flask-shaped epidermal cells. The Upper Verde populations have very pronounced apical callosities, some of which are extended into a narrow elongated or curved tip, like those of *S. platyphylla* (Fig. 1, I and J). Based upon field observations and the morphological study, including SEM of leaves and mericarps (Table 1), the Upper Verde populations are here described as a new variety of *S. platyphylla*, differing chiefly in habit and a vestiture of dense short eglandular hairs. The recognition of this new taxon within *S. platyphylla*, following Turner and Delprete (1996), is preferred until the species boundaries in sect. *Resinosa* have been more thoroughly investigated.

TAXONOMIC TREATMENT

Scutellaria potosina var. **kaibabensis** S. Rhodes & T. Ayers, var. nov. (**Fig. 2, A–E; Fig. 3, A–C**). TYPE: U.S.A. ARIZONA: Coconino Co.: East rim of the Kaibab Plateau, North Canyon Trail #4, 36°25'04"N 112°04'17"W (NAD 27), 2133 m (7000 ft), 9 Jul 1998, *Suzanne Rhodes 9811 with Tina Ayers* (HOLOTYPE: ASC; ISOTYPES: ARIZ, ASU).

Simile *Scutellaria potosina* var. *tessellata* cum caules simplici; foliis subsessilis; et vestis glandula sessilis sola vel raro cum pili brevi eglanduliferi.

Perennial rhizomatous herbs, 12–16 cm high. Stems simple, erect or ascending from a woody caudex, yellow-green, with scattered sessile glands, hirtellous to glabrous, hairs eglandular, retrorse; older stems persistent. Leaves sessile to subsessile, elliptic to obovate, 9–15 mm long, 5–7 mm wide, ca. 2× as long as wide, margins entire, apex rounded, adaxial surface glabrous except for dense sessile glands, abaxial surface with a few scattered short (<10μm) hairs in addition to sessile glands. Flowers axillary in upper stem leaves; calyx densely glandular; corolla 9–13 mm long, tube diameter at throat 3.9–6.0 mm, outer surface with sessile glands and short gland-tipped hairs, limb deep violet-blue, throat white with purple spots. Mericarps 1.0–1.5 mm long, black, with an obscure apical callosity on some papillae.

Plants of dry sandy soil, often near ephemeral drainages; east side of Kaibab Plateau and western House Rock Valley (Fig. 4); ponderosa pine-white fir, piñon-juniper, and interior chaparral associations (1250–)1950–2606 m [(4100–)6300–8550 ft]. Flowering May–August.

Scutellaria potosina var. *kaibabensis* is endemic to the eastern edge of the Kaibab Plateau in northern Arizona. The closest known populations of *S. potosina* are of var. *grahamiana* in southwestern Graham County, which occurs below 4,000 ft in elevation and var. *tessellata* in Pima, Cochise and Santa Cruz counties of southern Arizona, which is found between 3,500 and 5,500 ft. Var. *kaibabensis* occurs further northwest than any other known populations in sect. *Resinosa*, and 250 miles north of the nearest populations of *S. potosina*. This variety is the sole representative

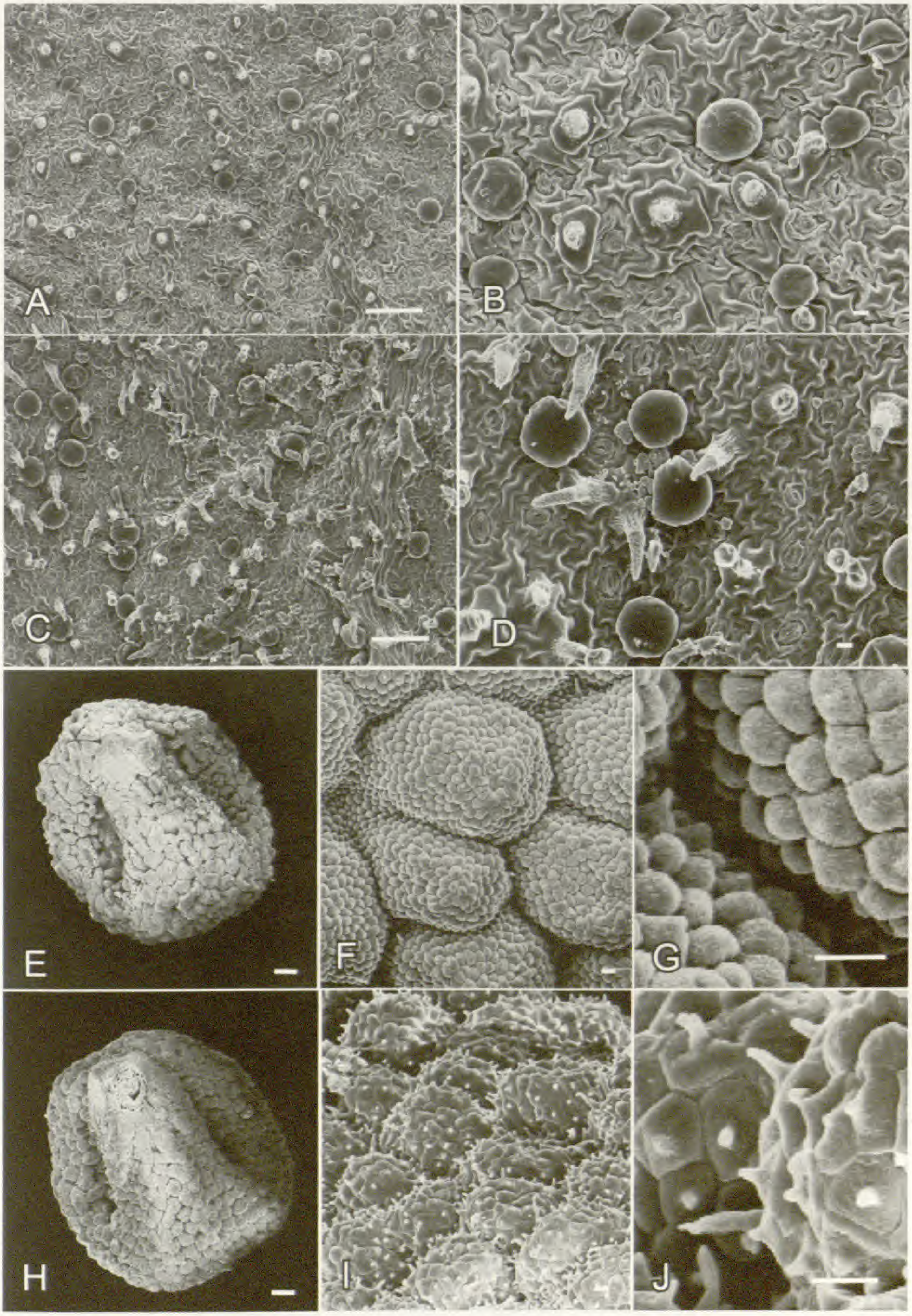

Fig. 1. Scanning electron micrographs of leaves and mericarps. **A–B:** *Scutellaria potosina* var. *kaibabensis* upper leaf surface; **C–D:** *S. platyphylla* var. *occidentalis* upper leaf surface; **E–G:** *S. potosina* var. *kaibaensis* mericarp; **E.** ventral view of mericarp, **F.** papillae, **G** detail of surface cells. **H–J:** *S. platyphylla* var. *occidentalis* mericarp; **H.** ventral view of mericarp, **I.** papillae, **J.** detail of surface cells. Scale bars: A, C, E, H 100 µm; B, D, F, G, I, J 10 µm.

Table 1. Morphological characteristics that distinguish the varieties of *Scutellaria potosina* and *S. platyphylla* in Arizona.

Character\Taxon	S. potosina var. kaibabensis	S. potosina var. grahamiana	S. potosina var. tessellata	S. platyphylla var. occidentalis	S. platyphylla var. platyphylla
Stem:					
architecture	simple	branched	branched	usu. simple	branched
height	12–20(–30) cm	33–38 cm	20–32 cm	12–17 cm	25–45 cm
sessile glands	dense, crowded	few, scattered	few, scattered	dense, crowded	dense, crowded
hairs, gland-tipped	absent	absent	absent	present	present
hairs, eglandular	sparse	sparse	sparse	dense	dense
Leaves:					
shape	elliptic-ovate	ovate	ovate	elliptic-ovate	lance-ovate
margin	entire	entire	shallowly crenate-dentate	entire	rarely minutely crenate
hairs, adaxial	absent	absent	few, scattered, 20–30 µm	dense, crowded, 20–30 µm	dense, crowded, >50 µm
hairs, abaxial <10 um	few, scattered, 20–30 µm	few, on veins only,	few, scattered, 20–30 µm	dense, crowded, 20–30 µm	dense, crowded, >50 µm
Flower:					
pedicel length	2 mm	2.5–3 mm	2–3 mm	2.5–3 mm	1–2 mm
corolla tube length	9–13	7–10	7–10	7–11	6–8
corolla tube basal diam.	1.2–2.0	(1.1–)1.5–2.4	1.1–2.3	1.5–3.2	1.0–1.3
corolla tube diam at throat	3.9–6.0	3.0–5.8	3.7–4.3	4.3–5.6(–6.3)	2.8–5.6
Mericarps:					
size	1–1.5 mm	*	1.2–1.8 mm	ca. 1.5	1.5–2 mm
papillae shape at apex	flattened	flattened	flattened	domed	domed
epidermal cell elongation	absent	absent	absent	present	present
Flowering time:	May–August (4100–)	May–June	May–Oct	May	Apr–Oct(–Jan)
Elevation:	6400–8400 ft	3950 ft	3500–5500 ft	5400–6400 ft	1980–2300 ft
Vegetation Community:	ponderosa pine/ gambel oak riparian	piñon-juniper riparian	Mexican oak/pine woodland riparian	piñon-juniper riparian	chaparral riparian

* mericarps have not been observed on any specimens of *Scutellaria potosina* var. *grahamiana*.

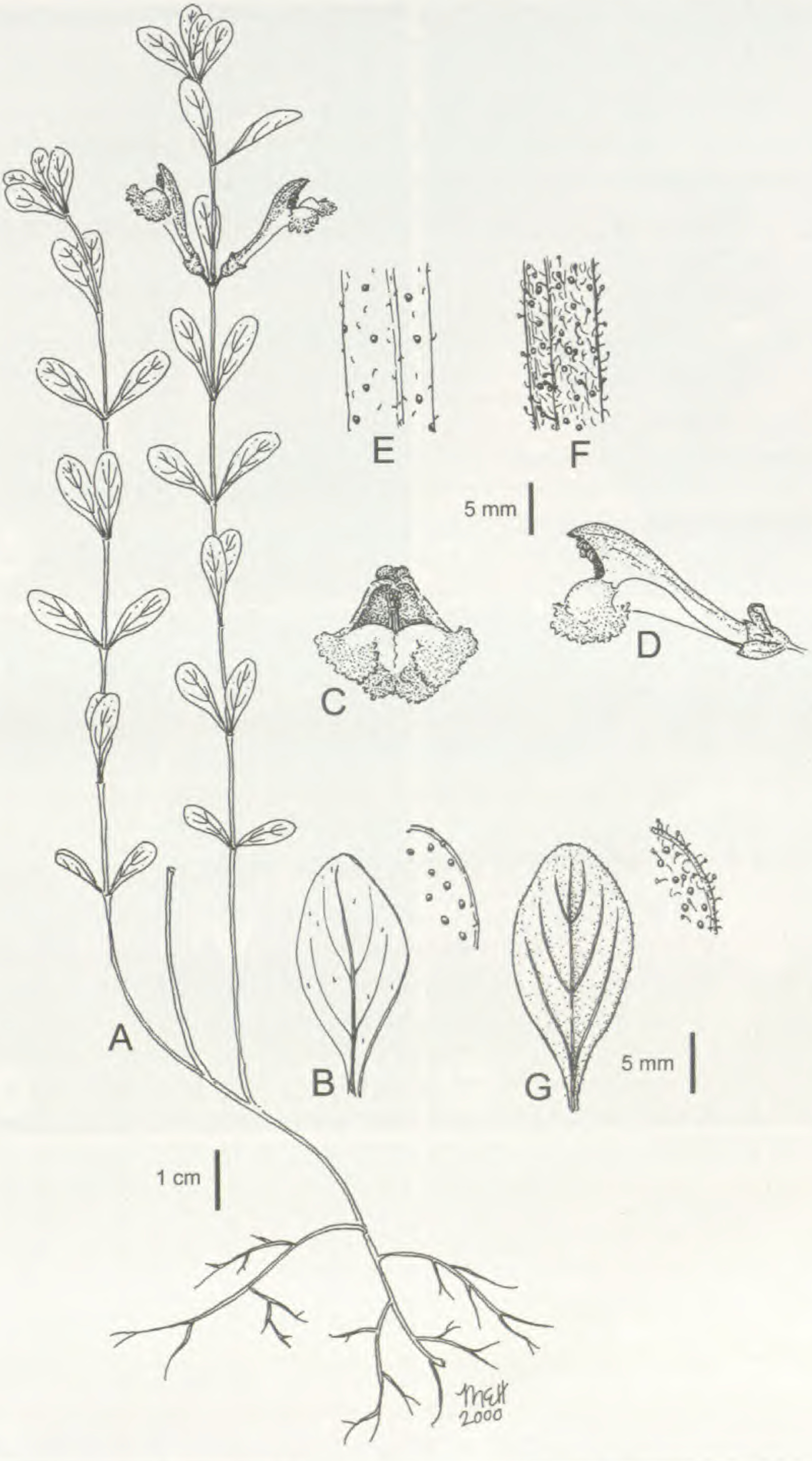

Fig. 2. **A–E:** *Scutellaria potosina* var. *kaibabensis*. **A.** Habit. **B.** Leaf blade with closeup showing vestiture. **C.** Corolla, front view. **D.** Flower, side view. **E.** Stem with glands and sparse eglandular hairs. **F–G:** *S. platyphylla* var. *occidentalis*. **F.** Stem with eglandular and gland-tipped hairs. **G.** Leaf blade with closeup showing vestiture.

found in the Colorado Plateau Floristic area, all other varieties are in the Apachean or Chihuahuan Floristic areas (McLaughlin 1986, 1989). The compact growth-form and larger corollas make this taxon particularly striking when in flower (Table 1). Variety *kaibabensis* is densely clothed with sessile glands but is otherwise glabrous or possesses just a few short hairs. The lack of eglandular hairs is similar to var. *grahamiana*, but the number and density of sessile glands, and architecture can easily separate the two.

Paratype: U.S.A. **Arizona. Coconino Co.:** Kaibab Plateau: East Rim View Point along Trail #7 ca. 2¼ mi down from trailhead, in North Canyon; 36°25'18"N, 112°04'22"W, 2133 m (7000 ft); 1 Jul 1993, *W. Hodgson 7334* (DES, ASU).

Additional specimens: U.S.A. **Arizona. Coconino Co.:** Kaibab Plateau, Marble Canyon Overlook, ca. ½ mi N of the end of FR 219, on ridgetop; 36°24'35"N, 112°03'28"W (NAD 27) 2606 m (8550 ft), 21 Jun 1999, *Rhodes 9954* (ASC); Marble Canyon, South Canyon trail, ca. 5 km upstream from the Colorado River 36°29'02"N, 111°54'07"W, 1244 m (4180 ft); 18 May 1996, *Stevens s.n.* (ASC); Kaibab National Forest, Cocks Comb, off FSR 445A, ca. 7 mi W of FSR 445, 36°23'37"N, 112°00'41"W (NAD 27) 1920 m (6300 ft); 20 Jun 1998, *Hodgson 11076* (ASU), *11089* (ASU, DES); North arm of Nankoweap Canyon between Sieber and Marion Points, below top of the Tapeats Sandstone,12S 415000E 4017380N (NAD 27) 5100 ft, 20 May 2008, *Rink 7091* (ASC); South Canyon, ca. 0.2 mi downstream from where the trail drops to the bottom of the canyon, growing along rocky ephemeral drainage channel, 12S 417366E 4036917N (NAD 84) 4400 ft, 6 May 2007, *Christie 1418* (ASC).

Scutellaria platyphylla var. **occidentalis** S. Rhodes & T. Ayers, var. nov. (**Fig. 2, F–G; Fig. 3, D–F**). Type: U.S.A. Arizona: Yavapai Co.: Limestone Canyon, 7 mi W of Hwy. 89 on FR 573, 35°01'30"N, 112°29'00"W (NAD 27), 1658 m (5440 ft), 10 Jul 1999, *S. Rhodes 9964* (holotype: ASC; isotypes: ARIZ, ASU).

Simile *Scutellaria platyphylla* sed cum caules simplici; foliis subsessilis; et vestis glandula sessilis et pili glanduliferi brevi.

Perennial rhizomatous herbs, 12–16 cm high. Stems simple, erect or ascending from a woody caudex, yellow-green with scattered sessile glands, densely hirtellous, hairs gland-tipped; older stems persistent. Leaves sessile to subsessile, elliptic to obovate, 11–19 mm long, 5–8 mm wide, ca. 2× as long as wide, margins entire, apex rounded, both leaf surfaces hirtellous with scattered sessile glands, short (20–30 microns) gland-tipped hairs, and a few sparsely scattered longer (>30 microns) hairs. Flowers axillary in upper stem leaves; pedicels 2.5–3.0 mm; calyx with dense sessile glands and gland-tipped hairs; corolla 7–11 mm long, tube diameter at throat 4.3–5.6 (6.3) mm, outer surface with minute, sparse hairs and scattered glands, limb dark violet, aging blue; throat white with purple spots. Mericarps 1.0–1.5 mm long, greenish-black with a prominent, often elongate apical callosity on the papillae. Plants of dry sandy soil; Upper Verde River drainage, northern Yavapai County (Fig. 4); Piñon-juniper associations. 1646–1950 m (5400–6400 ft). Flowering May.

Scutellaria platyphylla var. *occidentalis* is endemic to the Upper Verde River drainage of northern Yavapai County, where it is locally abundant. These populations occur as a northwestern range extension of the current distribution of *S. platyphylla*. Epling (1942) makes reference to a specimen collected near Ashfork (*Toumey 385*, ARIZ) in the exsiccatae for *S. tessellata*, but noted that it was anomalous with "pubescence like that of *S. resinosa*, but glandular" in his discussion of *S. potosina* subsp. *platyphylla*. This collection is the earliest specimen referable to this taxon. Variety *occidentalis* also has smaller corollas, a mixture of sessile glands, eglandular, and gland-tipped hairs, but the hairs are consistently a fraction of the length of the hairs found in var. *platyphylla*.

Paratype: **U.S.A. Arizona. Yavapai Co.:** 2.7 km SE of Rock Butte, Limestone Canyon, dry canyon bottom, N3871380, E370420, T18N, R2W, NW ¼ NE ¼ Sec.1; 1450 m (4760 ft), 23 Jun 1994, *M. Baker 11469* (ASU).

Additional specimens: **U.S.A. Arizona. Yavapai Co.:** Juniper Mesa, Dry, E facing slope south of Pine Spring; 326314, 3870895 (NAD 27) 1950 m (6400 ft); 9 Jun 2001, *Rhodes 215* (ASC); Juniper Mesa Wilderness Area, ca. 200 m SE of Pine Springs. 34.9635°°N, 112.90289°W, T18N, R6W, S9, 1954 m (6410 ft), 20 Jun 1992, *Baker 9598* (ASU); Juniper Mts, 50 yards S of FSR 7 and Mud Spring Rd, T18N, R6W, S4, 6000 ft, 18 May 1984, *Hodgson 2887* (DES); Ash Forks, 26 Jun 1892, *J.W. Toumey 385* (ARIZ).

KEY TO THE *SCUTELLARIA* SECT. *RESINOSA* TAXA IN ARIZONA

1. Plants densely pubescent on stems and leaves; pubescence of gland-tipped hairs **S. platyphylla**
    2. Stems rarely branched above middle; gland-tipped hairs ca. 0.1 mm long; plants of northwestern Yavapai County var. **occidentalis**
    2. Stems many-branched above middle; gland-tipped hairs 0.4–0.6 mm long; plants of Apache, Gila, Maricopa, and Pinal counties var. **platyphylla**
1. Plants with few hairs on leaf surfaces, pubescence of eglandular hairs **S. potosina**

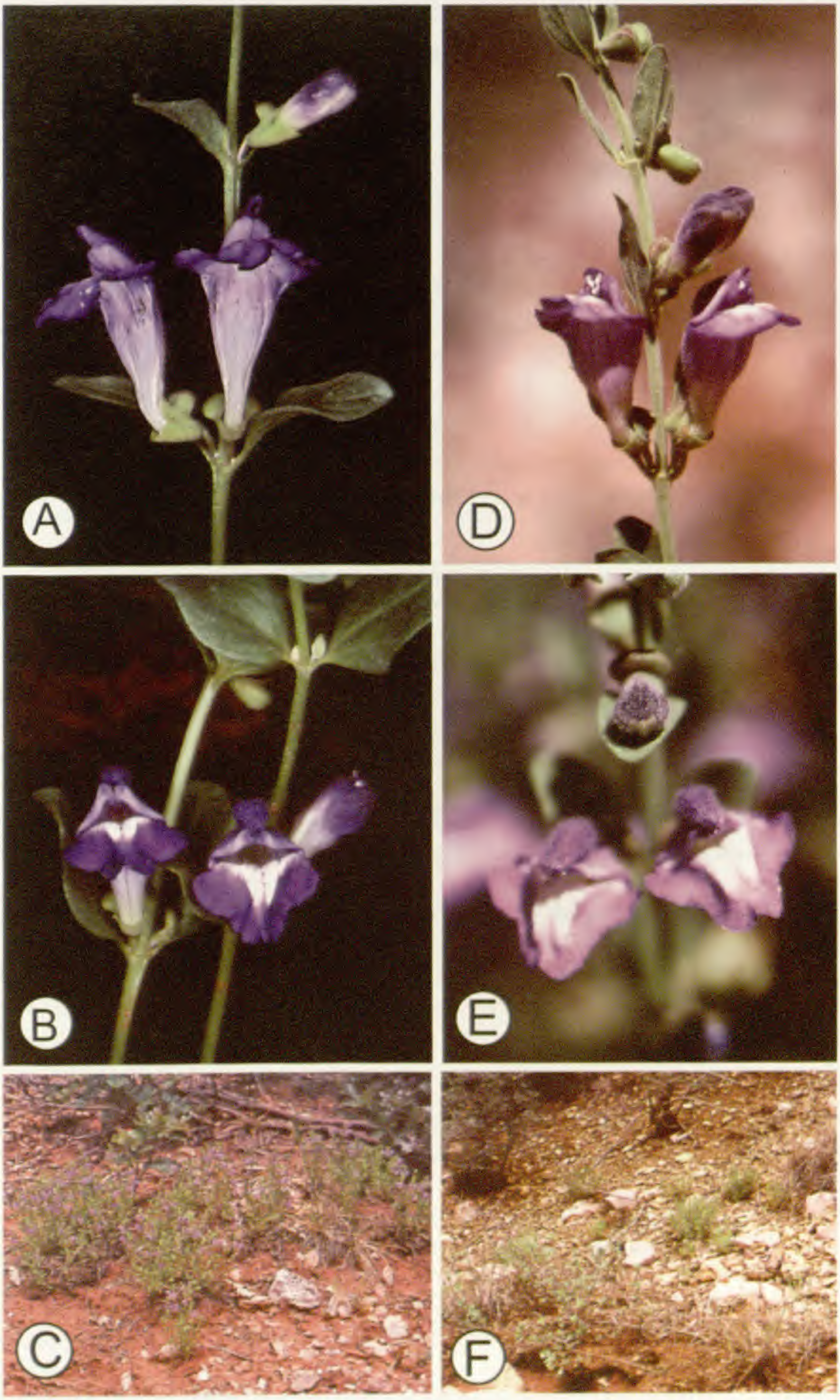

FIG. 3. A–C: *Scutellaria potosina* var. *kaibabensis*. A. Flowers. B. Corollas. C. Habit. D–F: *S. platyphylla* var. *occidentalis*. D. Flowers. E. Corollas. F. Habit.

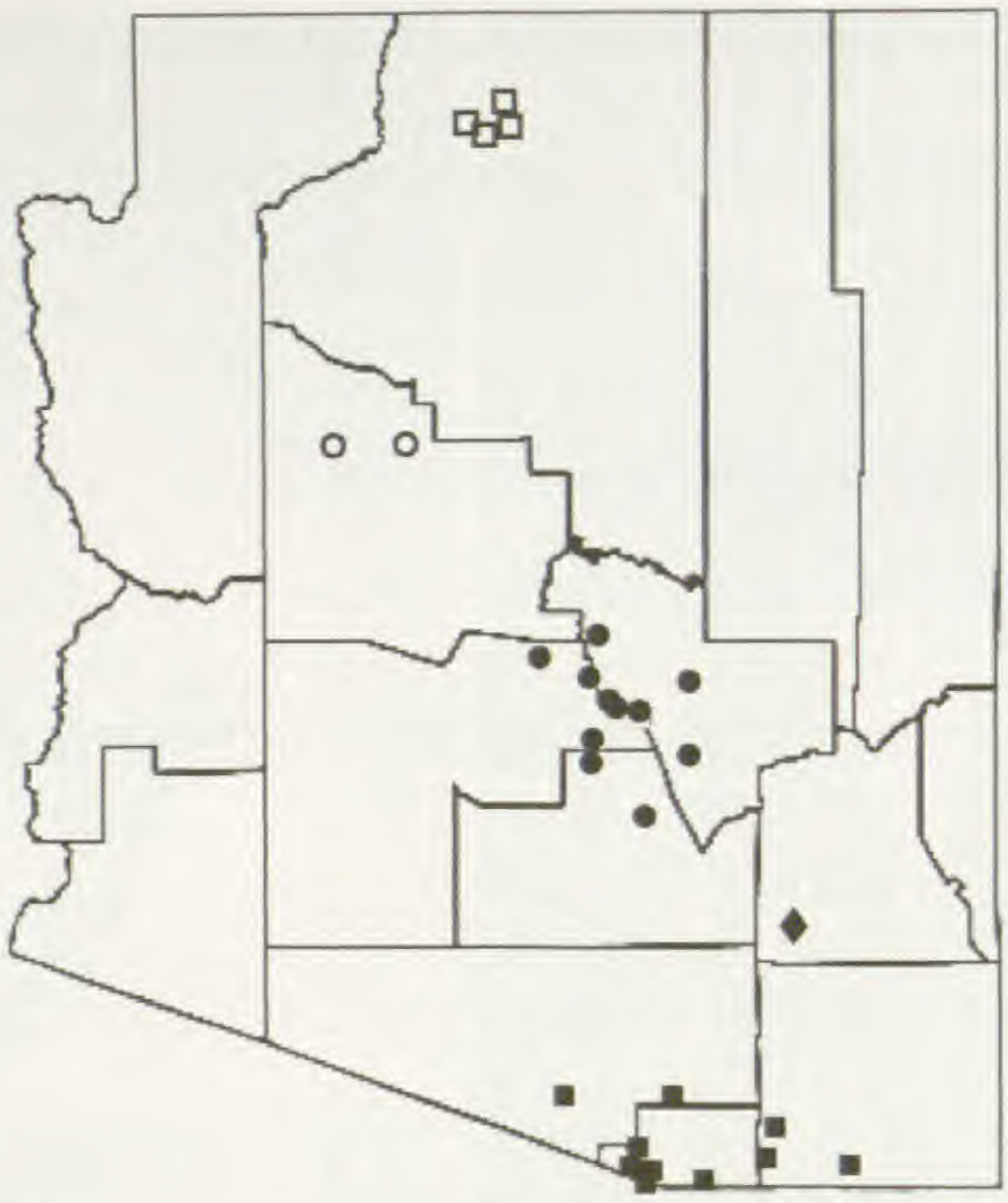

Fig. 4. Distribution of the *Scutellaria* sect. *Resinosa* in Arizona. *S. potosina* var. *tessellata* closed square (■), *S. potosina* var. *kaibabensis* open square (□), *S. potosina* var. *grahamiana* closed diamond (◆); *S. platyphylla* var. *platyphylla* closed circle (●), *S. platyphylla* var. *occidentalis* open circle (○).

3. Stems uniformly pubescent with a dense vestiture of short eglandular hairs; plants of Cochise, Santa Cruz, and Pima counties ______ var. **tessellata**
3. Stems glabrous or with a few scattered hairs.
    4. Stems simple, 12–16 cm tall, with sessile glands only or rarely with short eglandular hairs; leaves densely covered with sessile glands; plants of northern Coconino County ______ var. **kaibabensis**
    4. Stems branched above middle, 33–38 cm tall, with sessile glands and short eglanduar hairs; leaves with a few scattered sessile glands; plants of southwestern Graham County ______ var. **grahamiana**

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SALVIA CORIANA SP. NOV. (LAMIACEAE), A NEW SPECIES FROM A CLOUD FOREST IN WESTERN GUATEMALA

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ABSTRACT

Salvia coriana is a new species of herb described from two localities in a tropical montane cloud forest in western Guatemala. It appears to be closely related to *Salvia recurva*, but has blue corollas and a shorter corolla tube. A key to identify the *Salvia* species found on Pico Zunil is provided.

RESUMEN

Se describe **Salvia coriana** como una especie nueva, basada en material procedente de dos localidades en un bosque de niebla de Guatemala occidental. La nueva especie es parecida a *Salvia recurva*, pero difiere de ella por tener corolas azules con un tubo más corto. Se proporciona una clave para identificar las especies de *Salvia* presentes en el Pico Zunil.

Recent floristic work on Pico Zunil in western Guatemala has revealed a previously unknown species of *Salvia*, the largest genus in the Lamiaceae with over 900 described species (Hedge 1992; Walker & Elisen 2001). Its centers of diversity include Asia and the Americas, with up to 500 species found in the New World (Epling 1939; Hedge 1960, 1992; Harley 2004).

Salvia coriana Quedensley & Véliz, sp. nov. (**Fig. 1**). TYPE: GUATEMALA. QUETZALTENANGO. Municipio de Zunil: 5 km SE of Xela, NW slopes of Pico Zunil, dense cloud forest on trail above the hot springs Aguas Amargas, 2056 m, 9 Dec 2009, N14°45'23.4"W91°29'21.1" *T.S. Quedensley, M.E. Véliz & L.E. Velásquez M.10187* (HOLOTYPE: BIGU; ISOTYPES: CAS, F, NY, TEX, US).

Salvia recurva Benth. affinis sed differt corollis azureis tubis 8–10 mm longis labiis minoribus inequalibus, labio infero breviore quam labio supero.

Lianas to 12 meters in height, branches erect and arching, with striate, square stems. **Woody stems** 4–5 cm in diameter, sulcate, glabrate; younger stems green, sulcate, puberulent. **Leaves** opposite; petioles 3–5 cm long; blades 5–9 cm wide, 7–12 cm long, ovate to deltoid; margins coarsely serrate, bases truncate, apices acute to acuminate; adaxial surface glabrous, bullate; abaxial surface hispidulous on veins. **Inflorescences** 4–7 cm of lax, 3–6 flowered verticillasters. **Verticillasters** of flowers separated, forming interrupted racemes; subtended by deciduous bracts, lanceolate, apices acute to acuminate, ca. 2 mm wide, 3–4 mm long. **Calyces** becoming dark purple with age, strigose; upper lip 6–veined, 10–14 mm long, calyx apices acuminate. **Corollas** sky blue, corolla tube 8–10 mm long, upper lip hispidulous, 12–16 mm long; lower lip glabrous, reflexed, 9–11 mm long. **Stamens** 2, included, attached near base of corolla throat; filament 1.4–1.6 mm long; staminal papillae purple, 4 mm long, attached on corolla throat and perpendicular to filament. **Style** exserted, pilose, ca. 20 mm long, bifurcate, upper branch 2–3 times as long as lower branch. **Seeds** not observed.

Etymology.–The specific epithet refers to Jean Coria (1926–2008), loving friend to many at the San Francisco Botanical Garden and an avid grower of *Salvia*. Her kindness and sweet smile will never be forgotten by the first author of this paper.

KEY TO THE SPECIES OF *SALVIA* REPORTED FROM PICO ZUNIL

1. Corollas scarlet or red.
    2. Calyx in fruit less than 5 mm; herbs ____ **S. cinnabarina**

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2. Calyx in fruit 7–12 mm long; shrubs.
   3. Corolla tube ventricose **S. holwayi**
   3. Corolla tube not ventricose.
      4. Upper corolla lip 10–12 mm long, lower lip short or none **S. excelsa**
      4. Upper corolla lip 2.5–3 mm long, subbequal **S. curtiflora**

1. Corollas white, blue, or purple.
   5. Corolla tube 4–8 mm long.
      6. Inflorescence interrupted, the verticils of flowers separate **S. tiliaeifolia**
      6. Inflorescence dense and continuous.
         7. Calyx in flower 7–8 mm long, densely pubescent **S. hispanica**
         7. Calyx in flower 3.5–5 mm long, sparsely pubescent to glabrate **S. polystachya**
   5. Corolla tube usually 10–20 mm long.
      8. Corollas sky blue; liana **S. coriana**
      8. Corollas light purple; shrub **S. purpurea**

Distribution and habitat.—*Salvia coriana* is known from only two adjacent localities at approximately 2000 meters on the northwestern slopes of Pico Zunil. Pico Zunil (14°46'N; 91°27'W) is a mountain with a peak elevation of 3,542 meters (Williams 1960; Gall 1983; Quedensley & Bragg 2007). Pico Zunil is part of the Sierra Chuatroj range formed by the Zunil ridge that extends from south to north perpendicular to the Pacific coast between the departments of Quetzaltenango and Sololá (Fig. 2). The Sierra Chuatroj, located between Rio Samalá to the west and Rio Nahualá to the east, is part of a volcanic belt that extends 120 km from south of Guatemala City to the Mexican border. The two localities include the roadside to the hot springs Aguas Amargas, and trails through dense forest with rocky outcrops above the hot springs. Associated trees included *Billia hippocastanum, Bocconia arborea, Leandra subseriata, Oreopanax xalapensis, O. peltatus, Podachaenium eminens, Urera caracasana*, and *Wigandia urens*. Shrubs included *Alloispermum integrifolium, Aphelandra schiedeana, Monochaetum subtriplinervium, Montanoa pteropoda, Piptothrix areolaris, Tibouchina longisepala*, and *Vernonia arborescens*. Common herbs were represented by *Ageratum rugosum, Fleischmannia pycnocephaloides, Heterocentron subtriplinervium, Nasa triphylla* subsp. *rudis*, and *Salvia purpurea*.

Phenology.—Observed in flower in late December and early January.

This species appears to be morphologically related to *Salvia recurva*, but *S. coriana* is a liana, the leaves are smaller, the upper and lower corollas lips are shorter in length, and the corollas are blue. *Salvia recurva* has not yet been reported from the volcanic belt of Guatemala and in that country is known only from the Department of Huehuetenango at elevations above 2500 meters (Standley & Williams 1970). Morphology suggests that *Salvia coriana* is in the subgenus *Calosphace* (Benth.) Benth., and within the section *Dusenostachys* Epl. According to Standley and Steyermark (1946), 45 species of *Salvia* are found in Guatemala, and 312 species are located in adjacent Mexico (Ramamoorthy & Elliot 1993). Original collections of *S. coriana* included only two individual plants at the two reported localities. A return visit to the site in Dec 2009 revealed to the authors a large population of *S. coriana* above Aguas Amargas growing high up into cloud forest trees and shrubs. Pico Zunil has been documented to consist of relatively high numbers of endemic Guatemalan species, and two so far (*Ageratina zunilensis*: Asteraceae and *Stanmarkia spectabilis*: Melastomataceae) are considered to be endemic to the Sierra Chuatroj (Nash & Williams 1976; Almeda 1993; Quedensley 2007). More field work in the volcanic belt of Guatemala is required to illustrate the distribution of *S. coriana*, especially in the region of Pico Zunil.

PARATYPES: **GUATEMALA. QUETZALTENANGO. Municipio de Zunil:** 5 km SE of Xela, NW slopes of Pico Zunil, dense cloud forest on trail above the hot springs Aguas Amargas, 2094 me, 5 Jan 2006. N14°45'22.0" W91°29'21.4" *T. Sultan Quedensley & J.E. York 4810* (BIGU, F, TEX), disturbed cloud forest along road to the hot springs Aguas Amargas, 2000 m, 2 Jan 2008. N14°45'21.6" W91°29'21.6" *T. S. Quedensley & G. Yacalis 5173* (BIGU, CAS, F, NY, TEX, US, UVAL).

ACKNOWLEDGMENTS

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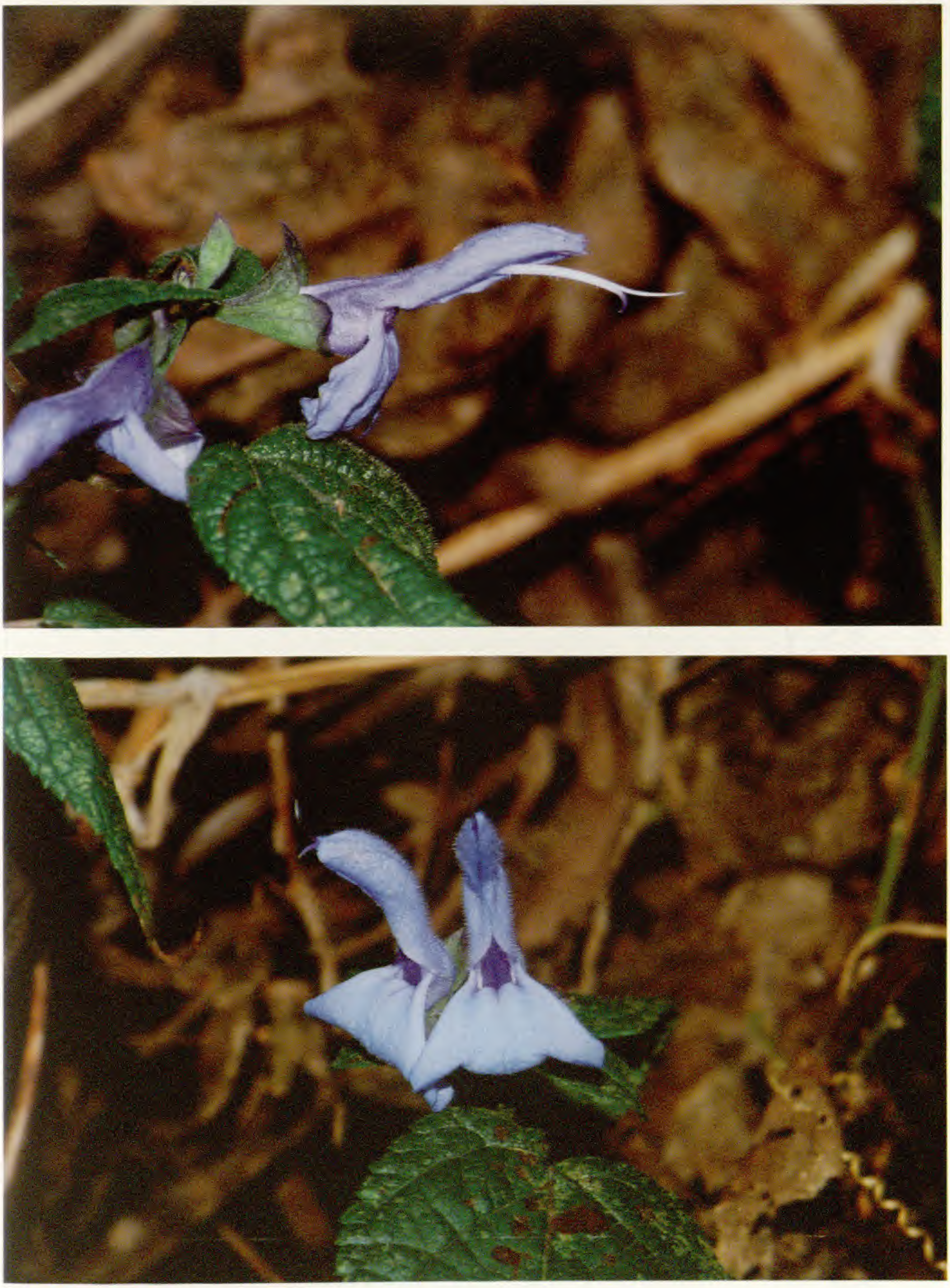

Fig. 1. *Salvia coriana.* **A.** Flower, side view. **B.** Flower, front view (Photos by T.S. Quedensley)

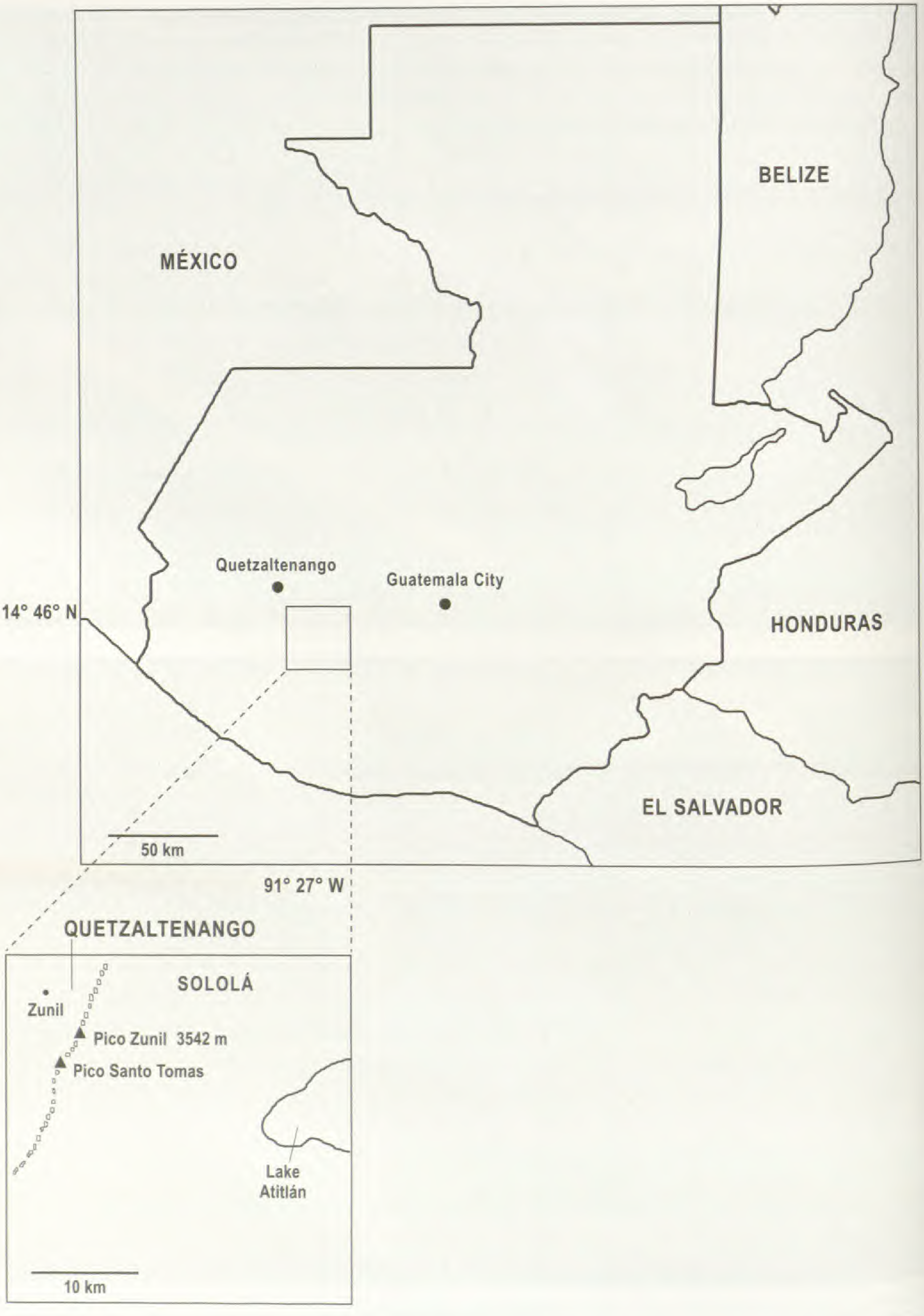
MÉXICO
BELIZE
Quetzaltenango
Guatemala City
14° 46° N
HONDURAS
EL SALVADOR
50 km
91° 27° W
QUETZALTENANGO
SOLOLÁ
Zunil
Pico Zunil 3542 m
Pico Santo Tomas
Lake Atitlán
10 km

FIG. 2. Type locality of *Salvai coriana* in Guatemala. Pico Zunil is located on the border between the departments of Quetzalteango and Sololá.

was also provided by the University of Texas at Austin College of Natural Scieces, Graduate College, and Plant Biology Graduate Program. Additional funding was provided by the NASA Nebraska & EPSCoR Space Grant Program, the Field Museum of Natural History in Chicago, the New York Botanical Garden, and the American Philosophical Society of America through the Lewis and Clark Field Scholar Program.

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BOOK REVIEW

Judith Larner Lowery. 2007. **The Landscaping Ideas of Jays.** (ISBN 978-0-520-24164-0, pbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., orders@cpfsinc.com, 1-800-777-4726). $25.95, 280 pp., 20 color plates, 6" × 9".

The Landscaping Ideas of Jays explores the natural history of a California backyard restoration project. Containing thirty two chapters in five sections (Fall, Winter, Spring, Summer, and the fifth season), this thoroughly researched book is full of anecdotal and historical views of California's native flora. The author mourns the disappearance of massive wildflower blooms of early California history, yet offers hope that some of the landscape can be restored and protected via restoration gardening. Her garden restoration partners include the western scrub Jay that she both views as an important architect of the California landscape and gives credit for 80% of the oak trees on her property.

Intertwined with practical gardening ideas and the author's infectious passion for California is an engaging look at the influential people of the states' native plant movement from the early 1900s, including Lester Rowntree, Edith Van Allen Murphey, and Gerda Isenberg.

I recommend this book to anyone interested in natural history as well as those contemplating a restoration project in any state as Mrs. Lowery's knowledge of native plants will inspire you.—*Gary L. Hinds, Nuclear Chemistry Instructor, Texas Master Naturalist (Rio Brazos), and BRIT volunteer.*

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A NEW SPECIES OF *CALCEOLARIA* (CALCEOLARIACEAE) FROM DISTURBED PARAMOS IN SOUTH ECUADOR

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ABSTRACT

Calceolaria molaui Puppo, sp. nov. is described and illustrated. The new species was collected in Loja, in disturbed paramos near the frontier with Peru so it would be expected to occur in northern Peru as well. It is characteristic for having hirsute indumentum composed of branched trichomes, ovate, subcoriaceous leaves with reticulate venation, cyme bracts absent, elaiophore absent, and brown, deflexed anthers, totally dehiscent. Due to its indumentum, leave shape, and anther morphology, *C. molaui* is placed in Section *Lehmannina* Pennell within subgenus *Calceolaria*. This is the only species of this section in southern Ecuador.

RESUMEN

Calceolaria molaui Puppo, sp. nov., es descrita e ilustrada. Esta nueva especie fue colectada en Loja, en páramos disturbados cerca de la frontera con Perú, por lo que podría encontrarse también en el Norte del Perú. Se caracteriza por tener indumento hirsuto compuesto de tricomas ramificados, hojas ovadas subcoriáceas con venación reticular, brácteas ausentes en la base de las cimas, elaióforo ausente, y anteras marrones, deflexas, totalmente dehiscentes. Debido a su indumento, hojas, y estambres, *C. molaui* es colocada como parte de la Sección *Lehmannina* Pennell dentro del subgénero *Calceolaria*. Esta es la única especie de esta sección descrita para el sur de Ecuador.

Calceolaria L. is the largest genus of the Calceolariaceae, comprising about 250 species distributed from central Mexico to southern Argentina. *Calceolaria* was formerly part of the Scrophulariaceae, but was raised to the family level together with *Porodittia* G. Don and *Jovellana* Ruiz & Pav. by Olmstead et al. (2001). Andersson (2006) found that *Porodittia* was nested within *Calceolaria*, leaving only two genera in the family.

Calceolaria is easily recognized by its yellow bilabiate flowers with saccate lower lip and two stamens (Molau & Sánchez-Vega 1986). Most of the species have a patch of glandular trichomes that produce oil. This structure is known as elaiophore (Vogel 1974) and is located in an infold of the lower lip in the corolla. *Calceolaria* species with an elaiophore are pollinated by specialized oil-gathering bees (Vogel 1974; Molau 1988; Rasmussen 1999; Sérsic 2004; Cosacov et al. 2009) while species lacking this structure are pollinated by common bees or bumblebees (Molau 1988; Sérsic 2004; Cosacov et al. 2009).

Calceolaria is subdivided in 3 subgenera and 22 sections (Molau 1988). Subgenus *Calceolaria* is the most frequent in the Neotropics, while subgenus *Cheiloncos* and *Rosula* are mainly distributed in the southern temperate. Many sections in Molau (1988) have been shown to be polyphyletic (Andersson 2006; Cosacov et al. 2009).

I here describe a new species collected in Loja, southern Ecuador that I detected during general identifications at the Missouri Botanical Garden in 2005.

Calceolaria molaui Puppo, sp. nov. (**Fig. 1**). TYPE: ECUADOR. LOJA: road Jimbura to Zumba, 3400 m, 6 Nov 2000, *P.M. Jørgensen et al. 2238* (HOLOTYPE: MO).

Suffrutex, caulibus strigosis, pilis ramosus fuscus eglandulosus. Folia decussata, peciolata; lamina subcoriacea, ovata, 2–2.7 × 1.2–1.9 cm, acuta, ad basin rotundata, margine crenatulus leviter revoluta; supra viridis, puberula; infra viridulus, reticulata venosa, in nervis hirsuta; petioli 2–3.5 mm longis, strigosi. Inflorescencia terminalis, numerosus cymarum; pedicelli 13–22 mm longis; bracteae cymarum desunt. Sepala viridis, ovata, 4–5 × 3–4 mm, acuta, puberula, intra tomentosum secus margines. Corolla flava, immaculata, labio superiore 5–7 × 6–8 mm, labio inferiore 9–15 × 7–9 mm; elaeophorus deest. Antherae fuscae, glabrae, 1.8–2.3 mm longis, totae dehiscentes; thecae aequales, deflexae; filamenta 1.4–1.5 mm longis. Stylus 4–4.5 mm longis. Capsulam conica, 5 mm longis, puberula, glutinosa.

Subshrub, stems strigose with ramified brown glandless hairs. Leaves decussate, petiolate; blades subco-

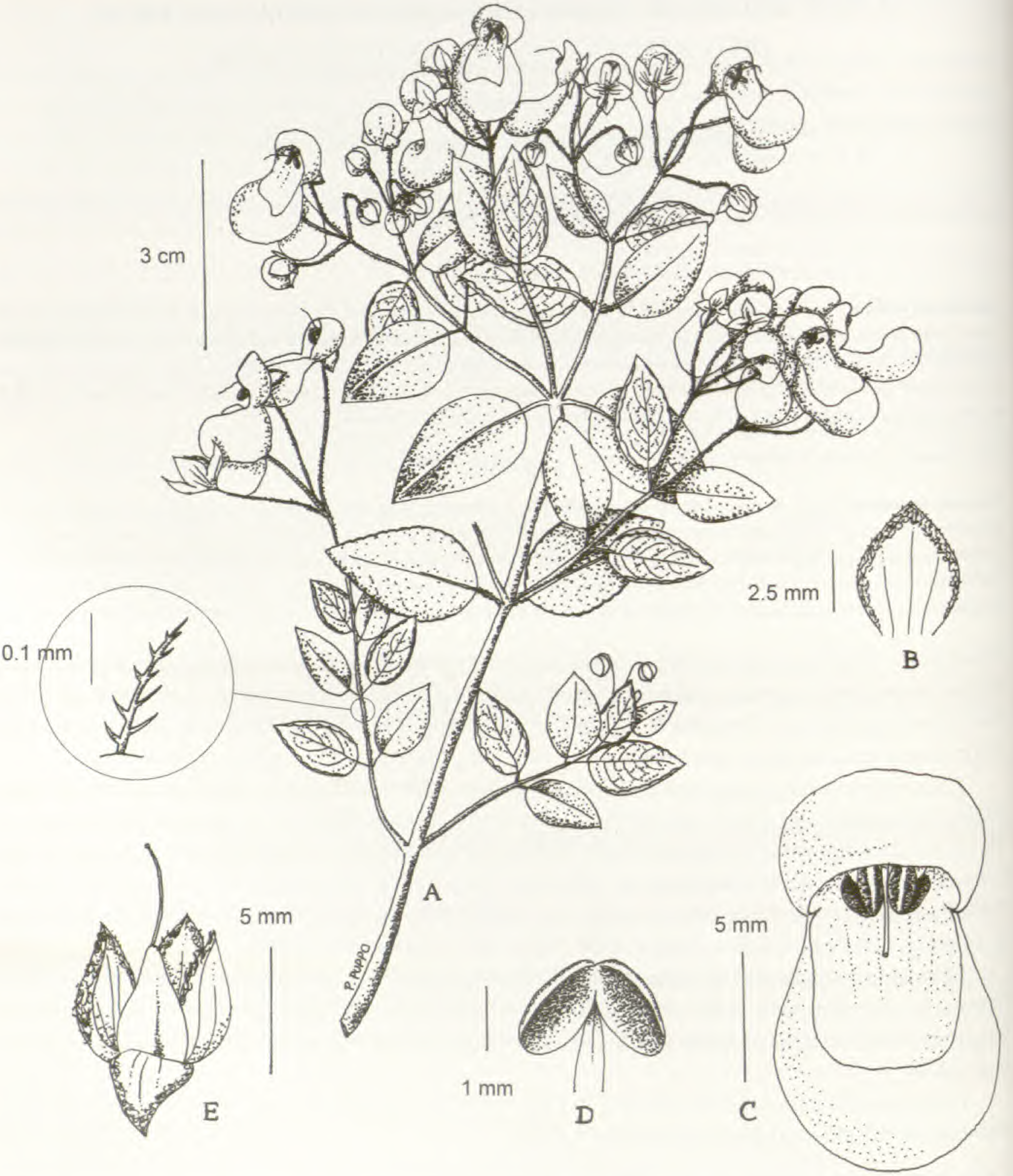

Fig. 1. *Calceolaria molaui* [*Jørgensen et al. 2238* (MO)]. A. Flowering branch with detail of a branched trichome. B. Sepal, abaxial view. C. Flower, frontal view. D. Stamen. E. Capsule.

riaceous, ovate, 2–2.7 × 1.2–1.9 cm, acute, rounded at base, the margins minutely crenate slightly revolute; upper surface green, puberulous; lower surface pale green, reticulate-venose, hirsute on the veins; petioles 2–3.5 mm long, strigose. Inflorescence terminal, composed of several cymes; pedicels 13–22 mm long; cyme bracts absent. Sepals green, ovate, 4–5 × 3–4 mm, acute, puberulous in both surfaces, internally densely pubescent on the margins. Corolla yellow, unspotted, upper lip 5–7 × 6–8 mm, lower lip 9–15 × 7–9 mm wide; elaiophore absent. Anthers brown, glabrous, 1.8–2.3 mm long, dehiscent throughout; the thecae equal, deflexed; filaments 1.4–1.5 mm long. Style 4–4.5 mm long. Capsules conical, 5 mm long, puberulous, glutinous.

Distribution and ecology.—This species is known only from the type locality in Loja. It was collected in disturbed paramo with patches of Andean forest at 3400 m. The area in which *Calceolaria molaui* was collected is near the border with Peru, it is therefore expected to occur in northern Peru as well.

Etymology.—The species is named after Ulf Molau, who has contributed to the knowledge of *Calceolaria* for several years.

DISCUSSION

Following the last treatment of *Calceolaria* (Molau 1988), *C. molaui* is placed in section *Lehmannina* Pennell because of its subshrub habit, subcoriaceous leaves, anthers totally dehiscent, and especially its hirsute indumentum. The species of this section are distributed from northern Colombia to southeastern Peru, growing in humid habitats usually above 2000 m (Molau 1988). This section however, has also appeared as polyphyletic in phylogenies presented by Andersson (2006) and Cosacov et al. (2009).

Although *C. molaui* is known only from the type specimen, it has a particularly combination of characters that makes it a clearly distinct species. The plant is covered with branched trichomes, the leaves are subcoriaceous and rounded at base, the cyme bracts are absent, the corolla lacks an elaiophore, and the anthers are deflexed. This is the first time that branched trichomes are described for *Calceolaria* thus constituting a unique character within this genus.

Other species from section *Lehmannina* present in Ecuador are: *C. cataractarum* Molau, *C. frondosa* Molau, *C. lehmanniana* Kraenzl., *C. martinezii* Kraenzl. and *C. pedunculata* Molau, all of these from northern and central Ecuador (Molau 1988; Jørgensen & León-Yánez 1999). *Calceolaria cataractarum* has elliptic or lanceolate leaf blades and the flower has an elaiophore. In *C. lehmanniana* the leaves are also elliptic or lanceolate but the corolla is white. In *C. molaui* the leaves are ovate, the corolla is yellow, and the elaiophore is absent. *Calceolaria frondosa* has herbaceous leaves less than 2 cm long, and the elaiophore is present while in *C. molaui* the leaves are subcoriaceous larger than 2 cm, and the elaiophore is absent. *Calceolaria martinezii* has lanceolate leaves, an upfolded lower lip that closes the corolla, and ascending thecae whereas *C. molaui* has ovate leaves, an open corolla, and deflexing thecae. Finally, *C. pedunculata* has glabrous leaves and triangular sepals while *C. molaui* has hairy leaves and the sepals are ovate.

Species from this section present in Northern Peru are *C. luteocalyx* Edwin and *C. hirsuta* Molau. *Calceolaria luteocalyx* has herbaceous leaves, yellow-green or brightly yellow sepals more than 9 mm long, the corolla is closed and the elaiophore is present. *Calceolaria hirsuta* has also herbaceous leaves, and the sepals are glabrous abaxially. Both species are restricted to the department of Amazonas in Northern Peru. *Calceolaria molaui* has subcoriaceous leaves, green sepals less than 5 mm long densely pubescent on the abaxial margins, open corolla and elaiophore absent.

Other species possibly related to *C. molaui* are *C. phaeotricha* Molau and *C. fusca* Pennel from section *Salicifoliae*. *Calceolaria phaeotricha* is restricted to a small area of the Cordillera Oriental in Ecuador while *C. fusca* occurs from South Colombia to North Peru. *Calceolaria phaeotricha* has simple trichomes only at the base of the petioles and upper branches. It has glabrous, glutinous leaves with pinnate venation, the cyme bracts are present, and the anthers are pale yellow. *Calceolaria molaui* is covered with branched trichomes, has hirsute, non glutinous leaves with reticulate venation, the cyme bracts are absent, and the anthers are brown. *Calceolaria fusca* has a closed corolla and elaiophore present while *C. molaui* has an open corolla and elaiophore absent.

Conservation status.—In Ecuador, the paramos are highly disturbed due to anthropogenic activities such as agriculture, provoked fires, cattle, reforestation with alien species, among others (Quizhpe et al. 2002). *Calceolaria molaui* was collected in the southern paramos and should be consider as a critically endangered species (CR) under the B2ab(iii) criteria of the IUCN (2001).

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POA UNISPICULATA, A NEW GYNODIOECIOUS SPECIES OF CUSHION GRASS FROM PERU WITH A SINGLE SPIKELET PER INFLORESCENCE (POACEAE: POOIDEAE: POEAE: POINAE)

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ABSTRACT

A new Peruvian, high Andean, gynodioecious, cushion grass, **Poa unispiculata**, sp. nov. is described and illustrated. It is unique among all American species of *Poa* by having inflorescences composed of a single spikelet. It seems closely related to *P. perligulata* and differs by having a more compact habit, multiple equitantly distributed overlapping leaf sheaths with short distichous blades, presence of one spikelet per inflorescence, and gynodioecy with long anthers in bisexual plants.

RESUMEN

Se describe e ilustra una especie nueva para Perú altoandino, ginodioica **Poa unispiculata**, sp. nov., "pasto cojín," que forma densas matas en cojín. Es la única especie del género *Poa* en América, que presenta inflorescencias compuestas por una sola espiguilla. Parece estar estrechamente relacionada con *P. perligulata* de la cual difiere por el hábito más compacto con múltiples vainas foliares que se solapan y se hallan equitativamente dispuestas entre sí, con hojas dísticas, superpuestas, equidistantes, láminas cortas, por la presencia de una única espiguilla por inflorescencia, y por ser plantas ginodioicas, con anteras largas en las plantas perfectas.

A curious grass from Cerro de Pasco, Peru, has remained unidentified for many years. Renewed attempts to identify this little, puna cushion grass, have led us to the conclusion that it is a new species of *Poa* L. Two of the coauthors (RJS and PMP) traveled to Cerro de Pasco, Peru (the type locality) to obtain more material for study. It is unique among the American species of the genus because its inflorescences are reduced to a single spikelet.

Poa unispiculata Davidse, Soreng & P.M. Peterson, sp. nov. (**Figs. 1A–V; 2**). Type: PERU. Pasco: Cerro de Pasco, 4 km S on road to La Oroya, forming thick cushion on level ground, soil moist, elev. ca. 4400 m, 29 Jun 1977, *J. Solomon 3334* (holotype: MO (perfect plants); isotypes: MO ♀ plants, SI, US ♀ plants, USM [not seen]).

A *Poa* L., species inflorescentiis unispiculis, apicis glumae retusis, apicis palearum profundis emarginis congeribus americanus diversa, recedit.

Plants herbaceous perennials, gynodioecious herbs forming low dense cushions to at least 19 cm in diameter and 1–1.5 cm thick; culms 1.5–4 cm long, decumbent, ascending, extensively branching intravaginally and rooting adventitiously from the lower nodes; prophylla prominent, about as long as adjacent sheaths, membranous, 2-keeled, glabrous but the keels densely covered with more or less erect prickle-hairs. **Leaves** strongly distichous, glabrous, 20–30 per culm (6–15 blades present at flowering, old blades disintegrating before the sheaths frequently with irregular fibers from their bases), crowded but more or less equitant along the culm, each at 1–2 mm above the next of the same rank; sheaths long persistent, smooth, glabrous, very pale, strongly 3-nerved at the base, 5-nerved near the apex but the marginal nerves notably less developed than the central and middle nerves; ligules to 1.5 mm long in lower leaves, graduated upwards to 3.1 mm long, prominent in the uppermost leaves, scarious-hyaline, smooth or sparsely scabrous below, glabrous, decurrent along the margins of upper sheaths, obtuse and prominent, and shallowly praemorse to acute with lateral dents flanking apex: blades, 3–8 mm long, 0.5–0.7 mm wide, divergent at nearly right angles at maturity, folded or open V-shaped in vivo, folded when dry, pale green, smooth, glabrous, 7–9-veined,

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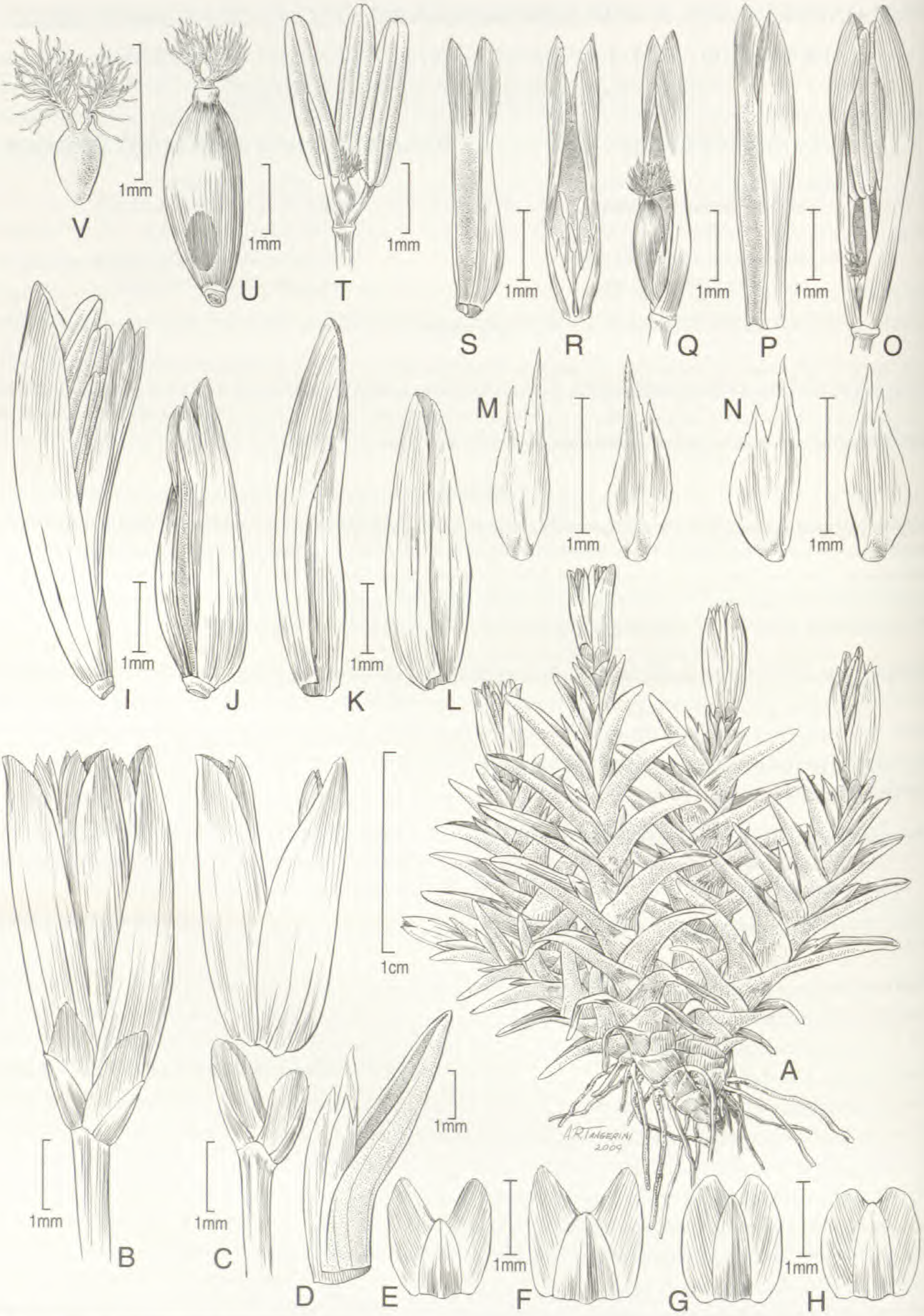
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Fig. 1. Illustration of *Poa unispiculata* Davidse, Soreng & P.M. Peterson. **A.** Habit of bisexual plant (paratype, US). **B.** Bisexual inflorescence. **C.** Pistillate inflorescence (isotype, US). **D.** Ligule of paratype. **E.–F.** Lower and upper glumes of B. **G.–H.** Lower and upper glumes of C. **I.–J.** Florets of B & C. **K.** Lemma of B. **L.** Lemma of C. **M.–N.** Lodicules of B & C. **O.–P.** Palea dorsal and ventral views of B. **Q.–S.** Palea views of C. **T.** Flower of B. **U.** Caryopsis of C. **V.** Pistil of C.

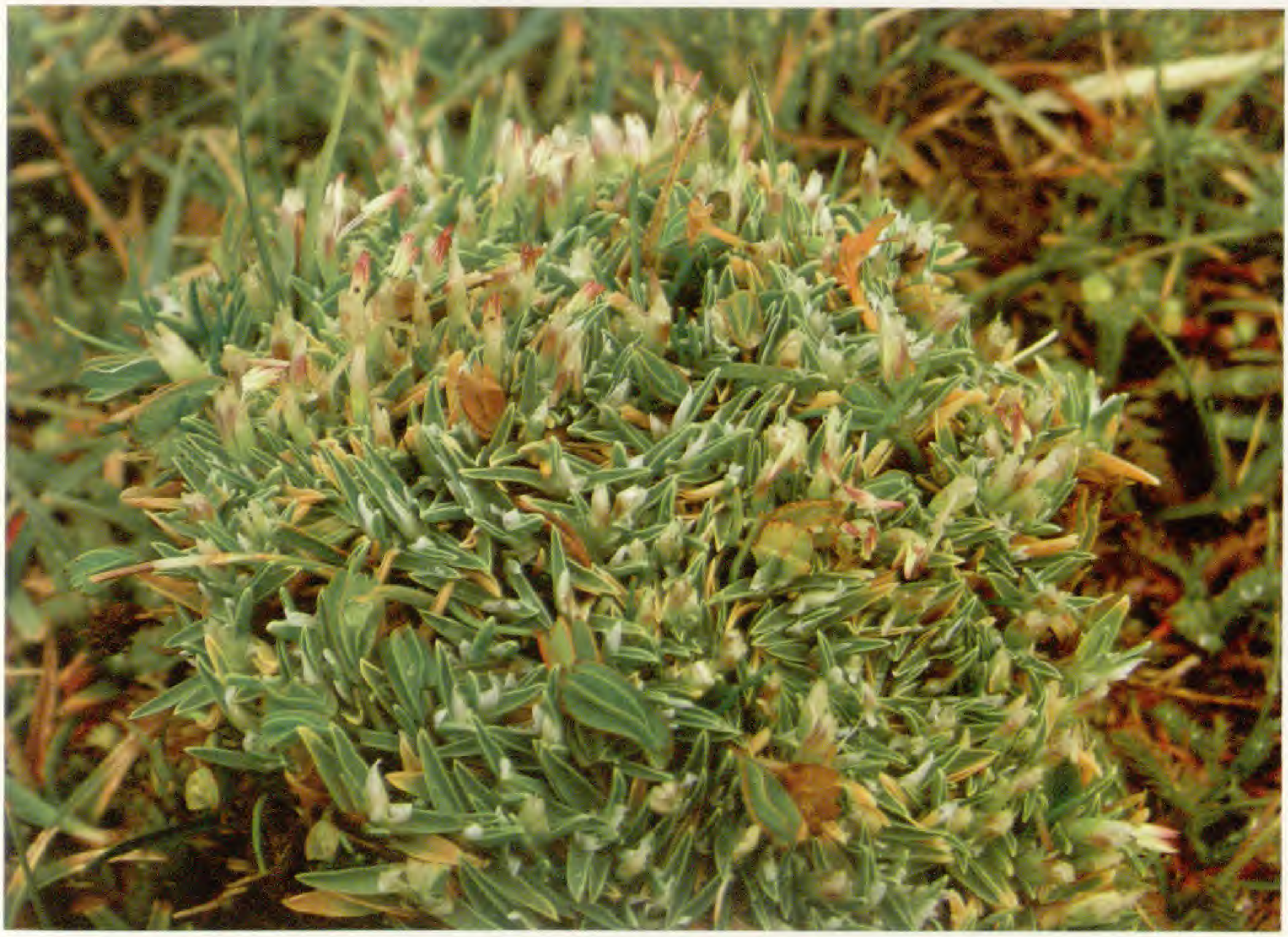

Fig. 2. Habit of *Poa unispiculata* [*P.M. Peterson, R.J. Soreng & K. Romaschenko 20382* (US)]. A bisexual individual in anthesis, *in vivo*, excavated and laying on top of the surrounding thatch. Photo by R.J. Soreng

the margins slightly involute and sparsely to regularly scaberulous, bases flattened and to 1.6 mm wide with age, abaxially smooth and shiny to slightly lustrous, with veins expressed, adaxially dull, smooth, with low narrow costae, apex blunt, the blade keel running in a nearly straight line (slightly upturned for ca 0.2 mm) into the apex, the margins being more downturned to meet the keel. **Inflorescence** composed of a single erect spikelet, barely exerted above the foliage; without nodal scars below the solitary spikelet; peduncles 5–6 mm long, smooth, glabrous, slightly thickened at the apex and laterally compressed. **Spikelets** slightly dimorphic, bisexual or functionally unisexual and pistillate, smooth, glabrous, 2(–3)-flowered (the 3rd, slightly reduced in all parts), often with a short rachilla extension to 0.4 mm long; glumes much shorter than the spikelets, keeled, about as broad as long, subequal, herbaceous in the central area, and broadly scarious-hyaline margins and lobes flanking the apex, edges smooth, apex obtuse to truncate or emarginate or retuse with a broad, U-shaped, 0.2–0.5 mm deep notch between the slightly flared, acute lobes; rachilla smooth, glabrous, terete, internode between 1st and 2nd floret mostly obsolete or up to 0.4 mm long, between the 2nd and 3rd florets ca. 1 mm long; callus of lemma not well-developed, blunt, glabrous, a narrow thickened rim at the base of the lemma; lemmas strongly laterally compressed and keeled, smooth, glabrous, thinly herbaceous in the lower 1/2–2/3, scarious-hyaline in the upper 1/3 and narrowly so along the margins to the base, apex and margins smooth, the lateral nerves extending ca. 1/2 way to the apex; palea slightly shorter to nearly as long as the lemma, smooth, glabrous, scarious-hyaline except for the thinly herbaceous keels and adjacent internerve and margins in the lower part, 2-nerved and 2-keeled, between the keels 0.5–0.7 mm wide in the sulcus, incised up to 1/3 the length, the 2 terminal lobes slightly flared in the distal ¼; lodicules 2, with or without a slender to 0.5 mm long lateral lobe nearly equaling the main lobe, smooth, glabrous; ovary glabrous, styles 2, ca. 1 mm long, terminal, bearing stigmatic hairs to

near the base, densely plumose, lateral branches simple; bisexual spikelets: lower glumes 1.3–1.6 mm long, 1–3-nerved; upper glumes 1.6–2.0 mm long, 1–3-nerved (both glumes 3-nerved in *Peterson, Soreng & Romaschenko 20382*); lemmas 4.9–5.5 mm long, 5(–7)-nerved, intermediate nerves faint, apex obtuse, slightly flared; lodicules 1.3–1.5 mm long, 0.3–0.5 mm wide, narrowly lanceolate, attenuate; stamens 3, filaments erect, apically exerted, anthers 2.3–2.6 mm long, glabrous; (pistil as in pistillate flowers but slightly smaller, and no caryopsis observed); pistillate spikelets: lower glumes 1.3–1.5 mm long; upper glumes 1.5–1.6 mm long; lemmas 3.3–4.6 mm long, 3-nerved, in the lower part becoming slightly thicker at caryopsis maturity, apex obtuse to truncate; lodicules 0.8–1.5 mm long, to 0.7 mm wide, asymmetrically elliptical; staminodes 3, 1.0–1.5 mm long including anthers, anther sacs 0.3–0.4 mm long, rudimentary, sterile; caryopses 1.3–1.5 × 0.4–0.5 mm, fusiform, brown, translucent, falling with the lemma and palea but not adherent to them, the adaxial (hilum) surface shallowly sulcate, the apex obtuse, the base acute; embryo ca. 1/3 as long as the caryopsis; hilum ca. 1/4 as long as the caryopsis, broadly elliptical.

Habitat.—Puna, 4380–4400 m, rare (ca. 10 clumps seen in 2007) in dense thatch, on low hummocks, and around the perimeters of shallow moist depressions in gentle, heavily and closely grazed, terrain, with *Aciachne* sp., *Alchemilla pinnata* Ruiz & Pav., *Calamagrostis minima* (Pilg.) Tovar, *Carex* sp., *Didymodon* sp., *Poa aequigluma* Tovar, and *P. humillima* Pilg. Other plants collected by J. Solomon at this location were: *Aloinella cucullifera* Steere, *Alternanthera lupulina* Kunth, *Astragalus* sp., *Baccharis caespitosa* (Ruiz & Pav.) Pers. var. *caespitosa*, *Barbula replicata* Taylor, *Bromus* sp., *Draba pickeringii* A. Gray, *Festuca rigescens* (J. Presl) Kunth, *Gentianella muscoides* (Gilg) T.N. Ho & S.W. Liu, *Senecio nutans* Sch. Bip., *Senecio spinosus* DC., *Senecio wernerioides* Wedd.

Comments.—*Poa unispiculata* is morphologically similar to *P. perligulata* Pilg., but differs by having a more compact habit with multiple equitantly overlapping leaf sheaths with short, tightly ranked, distichous blades, presence of one spikelet per inflorescence, and gynodioecy with long anthers in bisexual plants. We know of only one other species of *Poa* that consistently has a single spikelet per inflorescence (see discussion). Apical notching of spikelet bracts is rare in the genus, but also appears in *P.* [sect. *Anthochloa* (Nees & Meyen) Soreng & L.G. Gillespie] *lepidula* (Nees & Meyen) Soreng & L.J. Gillespie.

PARATYPE: **PERU. Pasco:** Cerro de Pasco, 4 km s, at junction of new and old roads to La Oroya (Hwy 3), 10°43'31.8"S, 76°15'08.4"W, 4382 m, 10 Mar 2007, perfect flowered plants only, *P.M. Peterson, R.J. Soreng & K. Romaschenko 20382* (B, CONC, CORD, K, LPB, MO, US, USM).

DISCUSSION

Poa unispiculata is reasonably placed in the "punapoa" complex of *Poa* (Soreng et al. 2003) which is now considered to include dwarf alto-andinean species with reduced inflorescences that are frequently diclinous or pistillate only and apomictic (Negritto et al. 2008). *Poa unispiculata*, like *P. perligulata* and some other punapoa species, has smooth palea keels and is thus problematical for separation from members of the *Catabrosa* complex [*Catabrosa* P. Beauv., *Catabrosella* (Tzvelev) Tzvelev, *Paracolpodium* (Tzvelev) Tzvelev, *Hyalopoa* (Tzvelev) Tzvelev] with multiple flowered spikelets. However, *P. unispiculata* has strongly keeled lemmas with occasionally up to seven nerves, and lacks epidermal papillae; whereas in the *Catabrosa* complex there are usually three or rarely five nerves, papillae are usually present on blades and culms, and the prophylla (palea homologues) keels are smooth (versus densely covered with more or less erect prickle-hairs in *P. unispiculata*, and variously scabrous in other punapoa). In analyses of nuclear ribosomal and plastid DNA data punapoa species resolve among species of *P.* subgen. *Poa* supersect. *Homalopoa* (Dumort.) Soreng & L.G. Gillespie, whereas the *Catabrosa* complex stands well apart from *Poa* (Gillespie & Soreng 2005; Gillespie et al. 2008, 2009). Within a broad survey of *Poa* and allied genera, preliminary ETS and ITS nrDNA sequence data place the new species nearest to *P. aequigluma* or *P. perligulata* in a clade with *P. lepidula* and *P. gymnantha* Pilg. (L.J. Gillespie pers. comm. Feb. 2010).

Poa is the largest genus of grasses (Gillespie & Soreng 2005) and is well known for its diverse breeding systems (Anton 1978; Anton & Connor 1995; Negritto & Anton 2000; Soreng 1991; Soreng & Keil 2003). Although bisexual species are the most common, species exhibiting dioecism, gynodioecism, and gynomonoecism are well known in both North and South America (Soreng 1991, 2007). A few andinean species are known only from populations composed of plants with pistillate spikelets, e.g., *P. perligulata* Anton & Connor 1995; Negritto & Anton 2000; Negritto et al. 2008).

Our judgment of breeding system of the new species is based on only three separate plants available to us for study from the type collection, and the one new collection of 10 plants (which we collected parts of). *Poa unispiculata* is judged to be a gynodioecious species because two of the cushions collected in the original gathering produced only pistillate spikelets and the third only bisexual spikelets. All individuals plants of the newer gathering had bisexual spikelets with anthers well exerted (Fig. 2), and no pistillate plants were found. No fruit were found in the bisexual spikelets from either gathering. Apparently all these individuals were collected from a single population from an area possibly less than 30m^2. The breeding system obviously needs confirmation and additional field studies are necessary. It could be that plants have bisexual flowers early in the season, and that a proportion of individuals shift to pistillate flowering later in the season (Soreng & Keil 2003). It is assumed that each cushion as collected is an individual plant that has attained it present dimensions through continual branching and rooting at the nodes, but because of the very dense, compact growth, it is impossible to be sure that no additional individuals were mixed within the cushions. To compensate for reduction in reproductive capacity of each culm harboring a single spikelet, a single mat of *P. unispiculata* can potentially produce several hundred flowering shoots per flowering season (e.g., the US isotype has approximately 200 flowering culms in one mat of 14 cm diam.).

Anton and Connor (1995) listed 14 other gynodioecious species then known from the Americas. The breeding system of four of the North American "partially gynodioecious" species was reclassified as sequentially gynomonoecious (Soreng & Keil 2003) and another as subdioecious (Soreng 2007), which is considered intermediate between gynodioecism and dioecism. Of the South American species listed, four belonging to *Poa* subgen. *Andinae* were transferred to a new genus, *Nicoraepoa* Soreng & Gillespie (Soreng & Gillespie 2007) [quite likely *P. stepparia* Nicora belongs here also], and one was reclassified as gynomonoecious, while yet another species was recharacterized as gynodioecious (Negritto & Anton 2000). Therefore, only four cases of gynodioecism exist in North America [*P. leibergii* Vasey, *P. stebbinsii* Soreng (which can also produce staminate inflorescences), *P. cusickii* Vasey subsp. *cusickii* and *P. chambersii* Soreng (both of which are gynodioecious in part of their ranges and dioecious over the rest), and two exist in South America (*P. cabreriana* Anton & Ariza and *P. lilloi* Hack.; Negritto & Anton 2000)]. So, actually gynodioecism is quite rare in *Poa*.

It is well known that dioecious species of *Poa* sect. *Dioicopoa* E. Desv. differ noticeably in the size of the spikelets, glumes, and florets (Giussani 2000; Soreng 2007; Soreng and Peterson 2008); pistillate spikelets have fewer and larger florets, and, if pubescent, have substantially more and longer hair. Differences among pistillate and perfect-flowered individuals of gynodioecious species of *Poa* have not been noted before, but are apparent in *P. unispiculata*. In this species the two spikelet types are slightly sexually dimorphic. The pistillate spikelets tend to have smaller and fewer florets, and the lemmas are 3-nerved, whereas the lemmas of the bisexual florets typically have an additional 1 (or 2) faint intermediate nerves. Besides the very obvious differences in the stamens, the pistils of the pistillate spikelets are slightly larger. Fruit set was abundant in the pistillate plant, but no fruit were observed in the bisexual plants, presumably because most of its spikelets were pre-anthesis or at anthesis. Possibly the pistils are infertile in the plants with fertile anthers (our bisexual plants), in which case the species is dioecious, but this would be an exceptional pattern in *Poa*, as pistils are rudimentary or at least more obviously reduced in species known to be dioecious. Solanaceae have minimally reduced sex organs in some dioecious species, but pollinator attraction and reward factors are in play there (Martineab et al. 2006) that do not apply to wind-pollination. In the bisexual plants the florets are longer and broader, and thus appear more prone to wind dispersal than those in the pistillate plants, which seems contrary to expectation unless they actually do produce seed.

As far as we are aware, 3-nerved lemmas are not known elsewhere in the genus (except in some species from New Guinea; Veldkamp 1994), but in *Poa unispiculata* this seems to be a clear specialization in an otherwise faintly 5(–7)-nerved species, as judged from the lemmas of the bisexual spikelets. This character state (often used to characterize genera and tribes) is clearly secondarily derived.

Another curious characteristic of *Poa unispiculata* is the flared scarious-hyaline margins of the glumes which extend upward as lobes beyond the herbaceous keel and back, leaving a U-shaped notch (Fig. 1. B, E–H), and the deep narrow notch between the somewhat flared and scarious-hyaline distal lobes of the palea. These are reminiscent of the flared scarious-hyaline margins of glumes, lemmas, and paleas, and notches of various depth in those, in *Poa lepidula*. The latter species was formerly treated as the sole species of the genus *Anthochloa*, but is now accepted as *Poa* sect. *Anthochloa*, and closely related to the punapoa group (Gillespie et al. 2007, 2008). The flared scarious-hyaline margins are an obvious adaptation for wind dispersal.

In *Poa*, inflorescence size varies widely from highly branched panicles with hundreds of spikelets as in large plants of *P. occidentalis* Vasey or *P. palustris* L. to highly compact inflorescences with very few spikelets primarily in species from high elevations on all continents except Antarctica. *Poa unispiculata* is thus an example of the ultimate extreme in panicle size reduction. It appears most closely related to a group of diminutive, alto-andinean species from the Andes of Peru, Bolivia, and northern Argentina and Chile (*Poa* group punapoa; in particular, *P. humillima*, *P. aequigluma*, *P. chamaeclinos* Pilg., and *P. perligulata* , the later three of which are generally recognized as strictly pistillate; Soreng et al. 2003). *Poa humillima* is gynomonoecious (Anton 1978) and differs in its more clearly naviculate leaf blades apices, abaxially smooth leaf blades, short branched, compact, ovate panicles 0.5–1(–1.5) cm long with less than 10 spikelets; single bisexual proximal florets with (1–)2 pistillate distal florets; broader, subflabellate upper glumes; shorter lemmas (2–2.8 mm long); scaberulous glume and lemma apical margins (x 50); all spikelets (2–)3-flowered; and fertile anthers ca. 1 mm long. *Poa aequigluma*, *P. chamaeclinos*, *P. perligulata* all have relatively longer glumes (subequal to the floret pair in *P. aequigluma* and *P. perligulata*), pistillate spikelets only (as do a few other South American species, and a several North American species at least in part), and only two florets per spikelet. Recently discovered populations of *P. aequigluma* from Ancash, Peru, at the northernmost end of the species range, have bisexual spikelets with normal looking anthers about 3 mm long (*Peterson, Soreng, LaTorre & Rojas Fox 21550, 21593, 21684*). These latter three species also share the obsolete or nearly obsolete rachilla internode between the proximal two florets with *P. unispiculata*. The leaf arrangement differs in these three species from that in *P. unispiculata*. All vegetative branching is intravaginal as in *P. unispiculata*, but leaves of the other species are fewer in number, the sheaths more elongated, and the leaf blades, which are mostly longer, diverge at approximately the same level (versus equitantly).

Inflorescences reduced to one or a few spikelets are relatively rare in Poaceae, but according to a search on the *World Grass Species* website (Clayton et al. 2002) are known in at least 73 other species in more than 30 genera, of which eight are annuals and 66 are perennials. However, among those species that produce inflorescences with single spikelets, the solitary condition is usually facultative. Individuals of most of these species also produce inflorescences with more than one spikelet.

We know of only a ten grass species that always have an inflorescence consisting of a single true spikelet (*Anomochloa* Brongn. and *Streptochaeta* Schrad. ex Nees can be excluded from our sample by not having fully evolved "grass spikelets"). This extremely rare condition is known in one other species of *Poa*, an alpine, cushion grass, *P. inconspicua* Veldkamp, from the Cartestensz Mountains of New Guinea (Veldkamp 1979, 1994). This species belongs to the remotely related *P.* sect. *Pauciflorae* Pilg. ex Potztal (L.J. Gillespie, unpublished DNA data), nine species of which have a single floret per spikelet, and seven others have 1–2 florets per spikelet (Veldkamp 1994). *Poa pygmaea* Buchanan, another unrelated, alpine cushion grass, from ca. 45° S in New Zealand, comes close in having inflorescences with 1–3 spikelets (Edgar & Connor 2000; Gillespie et al. 2009). One spikelet per inflorescence occurs rarely in depauperate specimens of *P. leibergii* Scribn [(1–)6–17(–22) spikelets] from the Pacific Northwest in North America. Obligate unispiculate inflorescences are additionally known in two of the three species of the genus *Aciachne* Benth. (Pooideae, Stipeae; *A. flagellifera* Laegaard and *A. pulvinata* Benth.) cushion plants of the high Andes and Costa Rica (páramo del Cerro Chirripó). In these two species the fully developed spikelet is subtended by one or two scars which may represent minute, vestigial spikelets. In the third species, *A. acicularis* Laegaard, inflorescences with two or rarely three spikelets may occur on the same plant with predominantly single-flowered inflorescences (Laaegaard, 1987). Obligate unispiculate inflorescences have also been reported in one species of *Rytidosperma* Steud. (Danthonioideae, Danthonieae), *R. oreoboloides* (F. Muell.) H.P. Linder, a cushion species from also from the Cartestensz Mountains of New Guinea where it grows intermixed with *Poa inconspicua* among other alpine plants (Veldkamp 1979). All of the above taxa with strictly one spikelet per inflorescence are from high elevation grasslands. *Lygeum* Loefl. ex L. (Pooideae, Lygeeae) with only the single species of low, arid Mediterranean hills, *L. sparteum* L., has a large single-flowered compound spikelet per inflorescence that is derived from the fusion of two spikelets that is subtended by a somewhat larger, loose spathe. The above genera have non-Kranz anatomy and presumably C_3 metabolism. A few other species with single spikelet inflorescences are known or presumed to have C_4 metabolism (Zuloaga 1987; Aliscioni et al. 2003). Within *Distichlis* Raf. (Chloridoideae, Cynodonteae) both of the species formerly treated as *Monanthochloe* Pilg. ex Potztal, *D. littoralis* (Engelm.) H.L. Bell & Columbus, coastlines of the southern United States and Mexico, and *D. acerosa* (Griseb.) H.L. Bell & Columbus, saline flats of northern Argentina (Bell & Columbus 2008), occur at sea level or in low plains up to ca. 350 m. The dwarf alto-andinean species *Distichlis humilis* Phil. has 1–4 spikelets, but can be distinguished from our species by the 7–11 veined lemmas. *Panicum cupressifolium* A. Camus (Panicoideae, Paniceae), which has single spikelets per inflorescence, occurs at moderately high elevations in the mountains of Madagascar (massif de L'Andringitra, 2000–2500 m) in a rocky/scrubby zone. Evidently, obligately single-spikelet inflorescences have evolved in grasses most commonly open habitats, in plants with C_3 metabolism, in alpine-like situations of tropical to subtropical latitudes.

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UNA NUEVA ESPECIE DE *FEVILLEA* (CUCURBITACEAE: ZANONIEAE) DE COSTA RICA

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RESUMEN

Fevillea narae, una nueva especie procedente del cantón de Tarrazú, al sur de San José, en la vertiente pacífica de la cordillera de Talamanca, Costa Rica, es descrita e ilustrada. Esta nueva especie representa la segunda especie de *Fevillea* para la región mesoamericana, junto a *Fevillea cordifolia*.

ABSTRACT

Fevillea narae, a new species from the cantón of Tarrazú along the pacific slope of cordillera Talamanca, Costa Rica, south of San José is described and illustrated. This species is the second species of *Fevillea* for the Mesoamerican region.

Fevillea (Cucurbitaceae) es un género neotropical, compuesto por lianas o bejucos dioicos y representado por 7 especies (Robinson y Wunderlin 2005; Monro 2009). Estas especies crecen usualmente a orillas de ríos, bordes de bosques, claros de vegetación y orillas de caminos y carreteras. El género se caracteriza por presentar hojas con glándulas; cáliz con escamas glandulares (excepto *F. passiflora*); pétalos con un apéndice o cresta adaxial sobre la costilla media que se extiende desde la base hasta la mitad del pétalo; flores estaminadas con 5 estambres, separados y anteras biloculares; frutos grandes, usualmente con una cicatriz circunferencial hacia el ápice (excepto *F. passiflora*) y semillas grandes (Robinson y Wunderlin 2005; Monro 2009).

La gran mayoría de especies del género son suramericanas; sólo *Fevillea cordifolia*, una especie ampliamente distribuida en todo el neotrópico, es conocida en la región de Mesoamerica y El Caribe (Jeffrey 2001; Robinson y Wunderlin 2005). *Fevillea narae* constituye la segunda especie de este género para la región y por el momento la primera especie del grupo con una distribución restringida a esta zona. La nueva especie es hasta ahora endémica de Costa Rica y se localiza al noroeste de la Cord. de Talamanca, en la vertiente pacífica central del país. Ésta es una zona de elevaciones medias, con bosques muy húmedos y nublados, una topografía abrupta con gran cantidad de ríos y quebradas y un pronunciado gradiente altitudinal, condiciones que favorecen una alta diversidad biológica, que actualmente presenta problemas serios de conservación por deforestación y alteración de los hábitats naturales. La región hasta hace poco ha empezado a explorarse más exhaustiva y sistemáticamente, dando como resultado el descubrimiento de varias especies nuevas como *Chamaedorea piscifolia* Hodel, G. Herrera & Cascante, *Lacmellea zamorae* J.F. Morales, *Epidendrum montis-narae* Pupulin & L. Sánchez S., *Macroclinium montis-narae* Pupulin, *Guarea constricta* Al. Rodr.; *Ruyschia moralesii* Hammel; *Ruellia norvegigratiosa* McDade & E. Tripp.

Fevillea narae A. Estrada & D. Santamaría, sp. nov. (**Figs. 1, 2**). TIPO: COSTA RICA: SAN JOSÉ: Cantón de Tarrazú, Distrito San Lorenzo, cuenca del Naranjo y Paquita, Quebrada Salitrillo, a 1km del cruce a San Isidro y Cerro Nara, 9°28'40"N, 84°02'00"W, 300–400 m, 2 Mar 2005 (fls. pistiladas), *D. Santamaría & J.F. Morales 821* (HOLOTIPO: CR; ISOTIPOS: INB, MO).

Species nova a omnibus speciebus generis Fevilleae per sequentes characteres distinguenda: Folia integra, glabra, laminae apex glandularis, sed petiolus, basis et margenes eglandulares, flores masculi solitarii vel inflorescentiis sub-umbelliformibus, brevibus et paucifloribus dispositi.

Esta nueva especie difiere del resto de especies del género *Fevillea* por sus hojas enteras, glabras, con glándulas en el ápice de la hoja, pero ausentes en peciolos, base o márgenes de la lámina; además, por sus flores estaminadas solitarias o en inflorescencias subumbeliformes cortas y poco floreadas.

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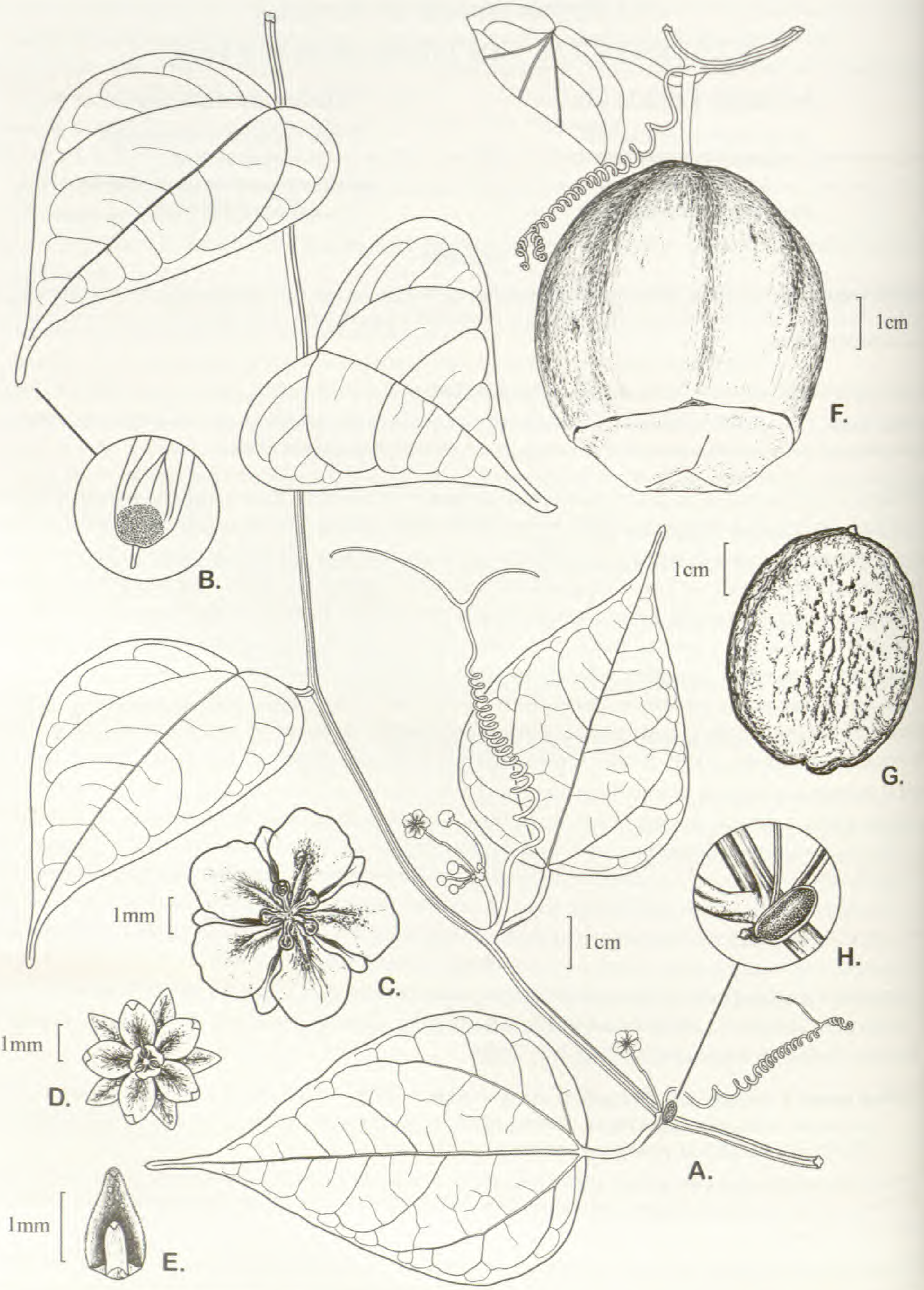
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Fig. 1. A–H. *Fevillea narae*. **A.** Hábito; **B.** Glándula apical; **C.** Flor masculina; **D.** Flor femenina; **E.** Sépalo con escama calicina; **F.** Fruto; **G.** Semilla; **H.** Bráctea estipuliforme.

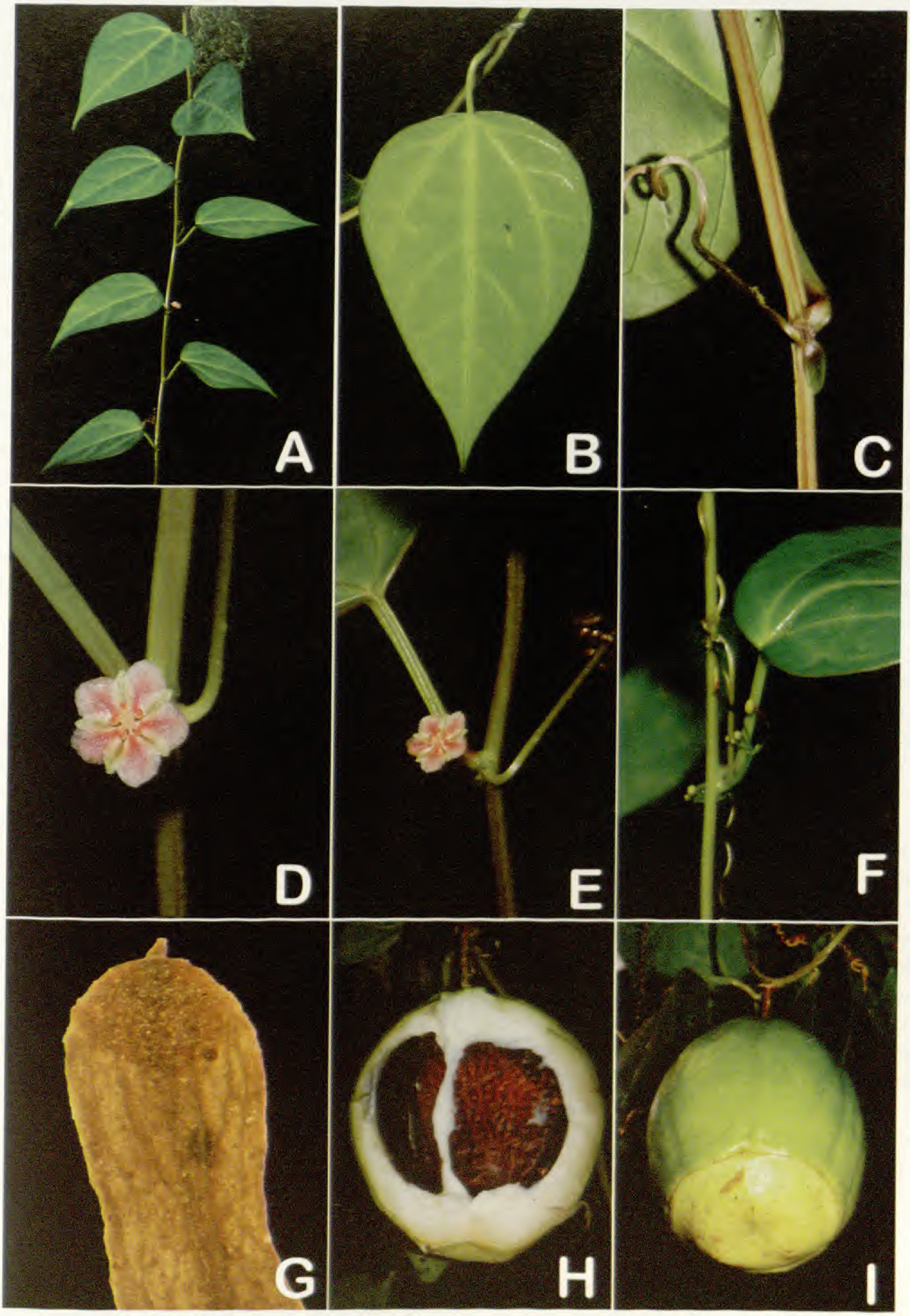


Fig. 2. *Fevillea narae*. **A.** Hábito; **B.** Hoja por el envés; **C.** Bráctea estipuliforme; **D** y **E.** Flor masculina solitaria; **F.** Inflorescencia masculina con botones florales; **G.** Ápice foliar glandular. **H.** Fruto partido longitudinalmente, mostrando las semillas. **I.** Fruto.

Bejucos dioicos; tallos sulcados, glabros; brácteas estipuliformes 5–6 × 3–3.5 mm, oblongas; zarcillos axilares, distalmente bífidos, glabros. Hojas alternas, con glándulas solo en los ápices; pecíolo 1.8–3.8 cm, caniculado, glabro, eglandular; lámina no lobulada, 5.5–12 × 2.5–7.5 cm, ovada, membranácea, glabra, secándose verde grisáceo a verde claro, trinervada, la base aguda a redondeada, truncada o levemente cordada, el ápice acuminado a caudado, con tejido glandular y terminando en una pequeña arista, el margen entero, sin glándulas. Flores estaminadas en inflorescencias axilares de 1 flor solitaria o en inflorescencias subumbeliformes de hasta 15 flores, con brácteas de 1–2 mm; pedicelos 6–7 mm, filiformes, glabros; hipanto 6–8 mm, pediceloide, glabro, los lóbulos 5, 2.5–3 × 1–1.5 mm, elípticos, agudos en el ápice, verdes, glabros, los márgenes papilosos, cada lóbulo con una escama calicina, saliendo desde la base hasta 2/3 parte del lóbulo; pétalos 5, 3–3.5 × 2.5–3 mm suborbiculares, con la base cuneada, rojizos, glabros, con los márgenes rosados o blanquecinos, con una cresta o apéndice adaxial ligeramente elevado sobre la costilla medial en la base de cada pétalo; estambres 5, libres; filamentos 0.5 mm de largo; anteras biloculares, extrorsas, dehiscentes longitudinalmente. Flores pistiladas solitarias, en pares o en inflorescencias subumbeliformes de 2–4 flores; pedicelos 0.7–3.2 cm; hipanto 2.0–2.5 mm, profundamente cupular, papiloso, los lóbulos 5, 1–1.5 × 1 mm, deltoides, verdes, glabros, con los márgenes papilosos, cada lóbulo con una escama calicina, saliendo desde la base hasta un poco menos de la mitad del lóbulo; pétalos 5, 1.5–1.7 mm, suborbiculares, con la base cuneada, pustulados, rojizos con los márgenes blanquecinos, con una cresta o apéndice adaxial ligeramente elevado sobre la costilla medial en la base de cada pétalo, con dos glándulas pequeñas suborbiculares a cada lado de la base del pétalo; estilos 3, libres, curvados hacia afuera; estigmas reniformes. Frutos 6.0–7.5 × 4.5–6.5 cm, elipsoides, con el ápice redondeado, verde claro, con una cicatriz circunferencial del hipanto hacia el ápice y una marca apical 3-radiada; semillas 5–6, 4–5.5 × 3.0–4.5 cm, orbiculares, 0.8–1.0 cm de grueso, compresas, café rojizo al secar, estriado-verrucosas, marginadas.

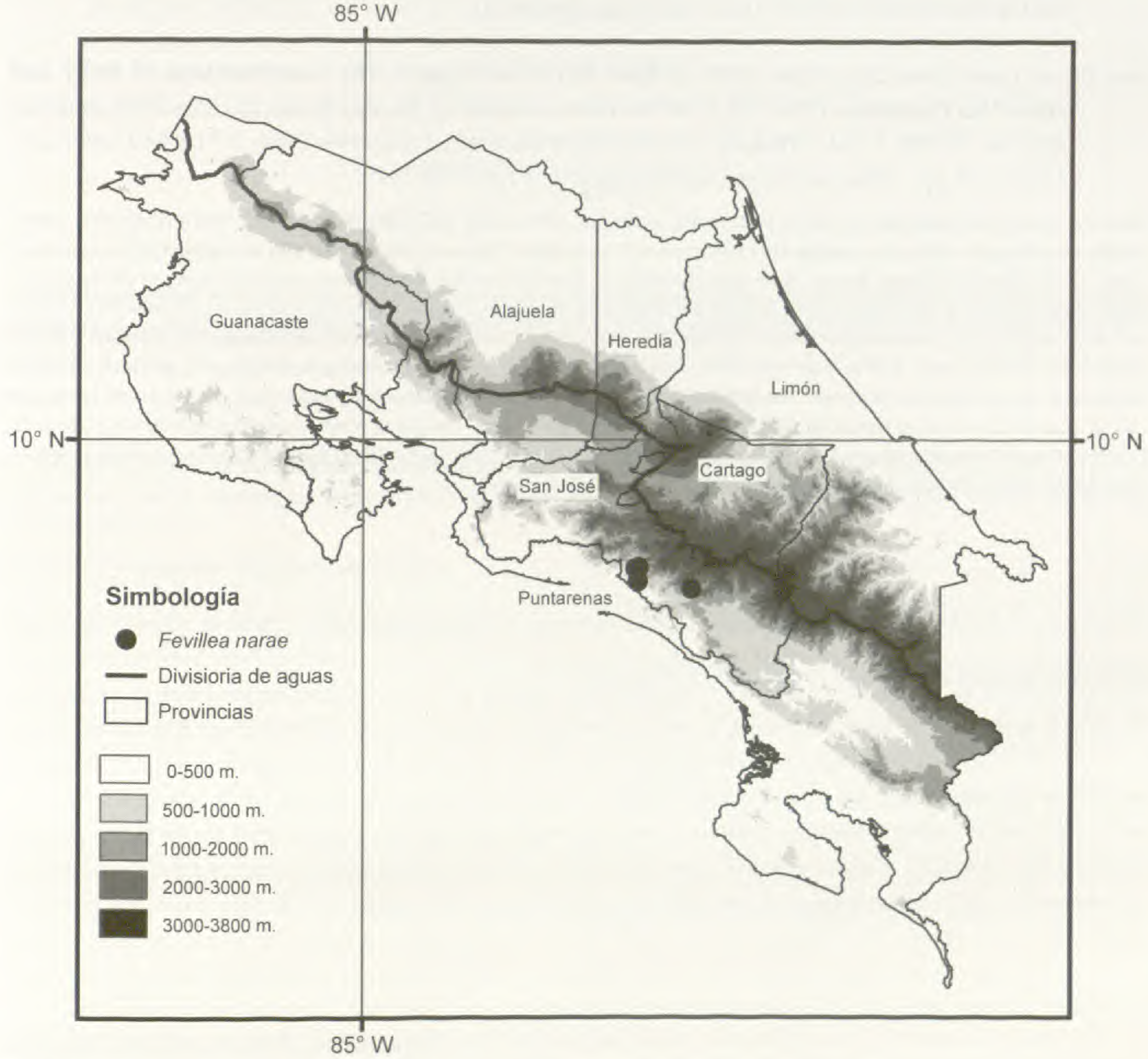
Fenología.—Flores estaminadas entre octubre y noviembre, flores pistiladas en marzo. Frutos en marzo, junio, julio y de setiembre a noviembre.

Distribución y Hábitat.—*Fevillea narae* es una especie endémica de Costa Rica. Se distribuye en bosques muy húmedos y pluviales en las estribaciones noroeste de la cordillera de Talamanca, en la vertiente pacífica (Cerro Nara y alrededores, cuencas del Río Naranjo, Savegre y División), entre 200 y 1000 m de elevación. Se ha recolectado en orillas de caminos y quebradas en vegetación secundaria (Fig. 3).

Discusión.—*Fevillea narae* se distingue del resto de especies del género por sus hojas enteras, glabras, con glándulas en el ápice de las hojas, pero ausentes en peciolos, base o márgenes de la lámina; además, se distingue por sus flores estaminadas solitarias o en inflorescencias subumbeliformes cortas y poco floreadas. A nivel infragenérico esta especie nueva puede ubicarse, de acuerdo a la clasificación de Robinson y Wunderlin (2005), en el subgénero *Fevillea*, en función de los pétalos suborbiculares, con una cresta levemente elevada en la base sobre la costilla medial (tanto en flores estaminadas como pistiladas); la presencia de un escama calicina en los lóbulos del cáliz (tanto en flores estaminadas como pistiladas); y los frutos con una cicatriz circunferencial hacia el ápice, el cual es redondeado. No obstante, a diferencia de los miembros de este subgénero, no presenta flores estaminadas en panículas largas y multifloreadas y además la costilla medial de la superficie adaxial de los sépalos no está fusionada con los márgenes de los pétalos.

Etimología.—El epíteto "narae" hace alusión a la localidad de donde procede esta especie, el cerro Nara, en el cantón de Tarrazú, San José.

Paratipos: **COSTA RICA. San José. Tarrazú:** San Lorenzo, Llanos de Santa María, 9°32'30"N, 84°1'20"W, 500–600 m, 23 Mar 1999 (fls pistiladas y frs), *A. Estrada 2074* (CR, INB, MO); 23 Jun1998 (frs), *A. Estrada 1618* (CR, INB, M); 9°32'40"N, 84°0'40"W, 800 m, 10 Jul 1997 (fls pistiladas y frs), *A. Estrada, O. Valverde, L. Gutiérrez & H. Gómez 983* (CR); Z.P. Cerro Nara, 9°29'40"N, 84°0'50"W, 900–1000 m, 3 Dic 1997 (frs), *A. Estrada 1339* (CR); alrededores de Cerro Nara, a 1 km de Escuela Pública de Nara, camino a San Isidro de Dota, 9°29'0.5"N, 84°0'44.5"W, 797 m, 27 Nov 2008 (frs), *A. Estrada & R. Chacón 4420* (CR, INB, MO); camino a Quebrada Arroyo, 4 km del cruce de Cerro Nara, 9°28'0.3"N, 84°1'12.9"W, 370 m, 30 Oct 2008 (fls estaminadas), *A. Estrada & R. Chacón 4387* (CR, INB). **Pérez Zeledón:** R.F. Los Santos, camino entre California y Zaragoza, 9°28'10"N, 83°49'20"W, 1000 m, 18 Set 2001 (frs), *A. Estrada, G. Vega & J. Sánchez 3054* (CR, INB, MO, M). **Puntarenas. Aguirre:** Naranjito, Dota, Quebrada Arroyo, Fila San Bosco, camino al Andarivel, 9°27'10"N, 84°0'50"W, 200–300 m, 2 Mar 2005 (fls pistiladas), *J.F. Morales 12172* (CR, INB).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Guanacaste
Alajuela
Heredia
Limón
Cartago
San José
Puntarenas
Simbología
● Fevillea narae
Divisioria de aguas
Provincias
0-500 m.
500-1000 m.
1000-2000 m.
2000-3000 m.
3000-3800 m.

Fig. 3. Distribución de *Fevillea narae* sp. nov. en Costa Rica.

AGRADECIMIENTOS

Los autores desean agradecer a la reserva y albergue "Los Campesinos" y a la comunidad de Quebrada Arroyo de Tarrazú, por el apoyo logístico brindado y por su afán de proteger y usar sosteniblemente los recursos naturales de su localidad. A Barry Hammel y Michael Grayum por la revisión y aportes al manuscrito; a Carlos O. Morales (USJ) por su ayuda en la elaboración de la diagnosis latina y a Claudia Aragón por las ilustraciones realizadas. A los revisores del artículo, Richard P. Wunderlin y otro revisor anónimo por las valiosas observaciones realizadas. A Rafael Chacón por su compañía y asistencia en las giras de campo.

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BOOK REVIEW

Rick Bennett and Susan Calla (eds). 2009. **A Rare Botanical Legacy: The Contributions of Ruby and Arthur Van Deventer.** (ISBN 978-1-59714-116-1, cloth hbk.). Heyday Books, P.O. Box 1945, Berkeley, California 94709, U.S.A. (**Orders:** www.heydaybooks.com, 1-510-549-3564, 1-510-549-1889 fax). $35.00, 154 pp., 100+ paintings and photographs, 9 1/4" × 12 1/4".

From the time of their marriage in 1915 to their deaths in the mid-1970s, Ruby and Arthur Van Deventer were a remarkable couple. A high-school teacher, Ruby also managed her family's ranch in northern California, while Arthur was an engineer and at one time a ranger in the Klamath-Siskiyou forests. Their mutual interest in plants led to their extraordinary botanical legacy of plants and art. Ruth collected plants in Del Norte County, finding and identifying the county's native plants, often contacting botanist Willis Jepson who was compiling his comprehensive flora of the state. The plants of the county had not before been documented, so Jepson was most appreciative of Ruth's work. Arthur made watercolor paintings of the plants, probably producing as many as 400, of which a hundred and twenty are reproduced in this book. The paintings are lovely and graceful if not botanically exact. Ruth Van Deventer's herbarium of 3500 plants is deposited in Humboldt State University, while her manuscripts along with Arthur's paintings and drawings are in the Del Norte County Historical Museum in Crescent City. Adding to the charm of this work is David Rains Wallace's essay on the couple.—*Joann Karges, Texas Christian University Library (retired), Fort Worth, Texas, U.S.A.*

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A NEW SPECIES OF *ANGELONIA* (PLANTAGINACEAE) FROM MEXICO

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ABSTRACT

Angelonia parviflora Barringer, sp. nov. is a new species from Yucatán and Quintana Roo, Mexico. It differs from other Mexican species of *Angelonia* by its small flowers and fruits. It is geographically isolated on the limestone savannas of the northern Yucatán Peninsula.

KEY WORDS: *Angelonia*, Plantaginaceae, Mexico

RESUMEN

Se describe una nueva especie, **Angelonia parviflora** Barringer, sp. nov., de la Península de Yucatán, México. Ésta difiere de las otras especies mexicanas de *Angelonia* por sus pequeñas flores y frutos. Se desarrolla geográficamente aislada en sabanas calizas del norte de la Península de Yucatán.

PALABRAS CLAVE: *Angelonia*, Plantaginaceae, México

Angelonia Humb. & Bonpl. (Plantaginaceae) is a genus of about 25 species growing mainly in seasonally dry lowlands from the Caribbean and southern Mexico to Argentina. A few species are cultivated and have escaped in tropical regions worldwide. The species have distinctive flowers with a pair of shallow, saccate nectaries behind the lower lip. These contain elaiophores, mats of glandular hairs that produce a fatty oil (Vogel 1974). Centris bees, who collect the oil as a larval food, are the principal pollinators.

All of the *Angelonia* species that grow in Mexico, Central America, and the Caribbean are in Section *Angelonia* (Barringer 1982). Species in Section *Angelonia* have a shallow, depressed palate at the base of the median corolla lobe that is a landing platform for pollinating bees. There is a small, cylindric, apically bifid tooth on the outer edge of this palate. The exact function of this tooth is not known, but pollinators appear to hold on to it while visiting flowers (Vogel 1974). These species appear to be derived from the South American species, which have a greater diversity of palate and tooth morphologies (Barringer 1982).

An undescribed species of *Angelonia* grows along the northern tip of the Yucatán Peninsula in fields and savannas over limestone. It has the smallest flowers in the genus, which suggests a distinctive pollinator, as well as the smallest fruits.

Angelonia parviflora Barringer, sp. nov. (**Fig. 1**). TYPE: MEXICO. YUCATAN: Progreso, km 31, Mérida road, in cleared marshy flats, Jul 1938, *Cyrus L. Lundell & Amelia A. Lundell 8028* (HOLOTYPE: US; ISOTYPES: F, GH, NY).

A *Angelonia angustifolia* Benth. foliis glandulosis, sepalis acutis ad 2 mm longis, capsulis ad 5 mm latis.

Annual *herb*; roots fibrous, branching from a short taproot; stem erect, to 20 cm tall, glabrous or glabrescent with glandular trichomes, slightly 4-angled, sometimes branching from near the base. *Leaves* opposite, sessile, lanceolate, 3–4 cm long, 0.8–1 cm wide, green, glandular-pubescent, membranaceous, not gland-dotted, the base narrowed, the margin serrate, the apex acute. *Inflorescence* a terminal raceme, slightly glandular-pubescent; *pedicels* 1 cm long, glandular at the base, bracteolate or ebracteolate; *sepals* ovate, 2 mm long, 1 mm wide, glabrous, the margin opaque, the apex acute; *corolla* purple; tube 3 mm long, 5 mm deep, the sacs 1–2 mm deep, with two pads of glandular trichomes on the forward surface within, the upper lobes obovate, 3 mm long, 2–3 mm wide, ciliate; lateral lobes obovate, 3 mm long, 2 mm wide, ciliate, abaxially glabrous, median lobe oblong to obovate, 4 mm long, 1–3 mm wide, adaxially glandular-pubescent, abaxi-

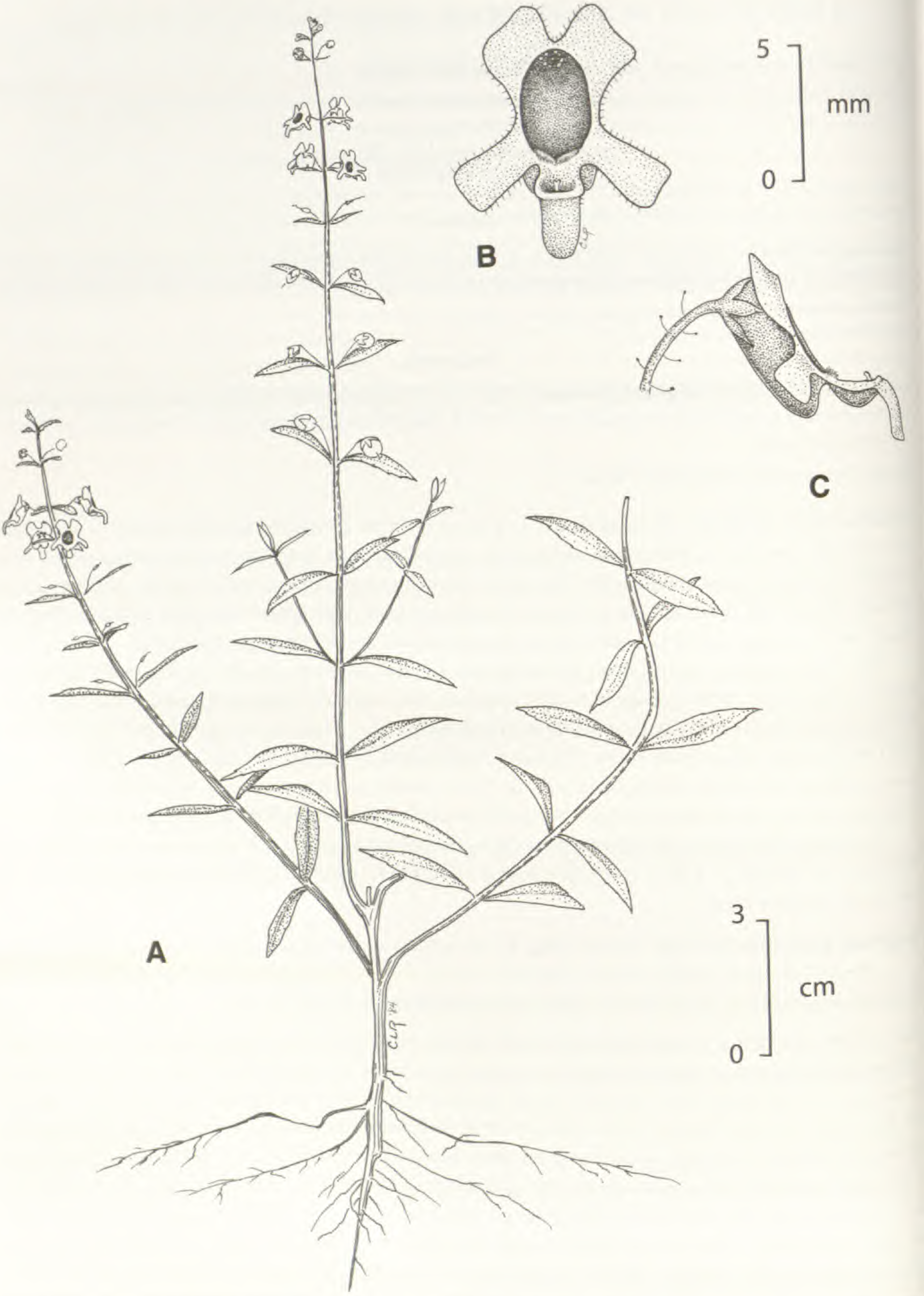

Fig. 1. *Angelonia parviflora* Barringer. **A.** Habit. **B.** Corolla. **C.** lateral view of flower.

ally glabrous, palate crateriform, 3 mm long 2 mm wide, ciliate; horn 1 mm tall, bifid; *stamens* 4 mm long, the filaments glandular-pubescent, the thecae ellipsoid, sessile, divaricate; ovary and style glabrous. *Capsule* globose, 4–5 mm diam., thin-walled, matte; fruiting pedicel slightly recurved, 0.8–1.0 cm long; *seed* light brown, obpyramidal to obconic, 0.5–1.5 mm long. 0.5–1.5 mm wide, the exotesta reticulate, the longitudinal walls not elongate, the margins slightly thick, the radial walls striate, imperforate.

Distribution and Habitat.—Mexico (Yucatán & Quintana Roo). Seasonally wet, open grasslands and thorn scrub on stony, pitted land. (Fig. 2).

Vernacular names.—This is one of the species called "Xac-xvi," "Xacxiu" "Xakxiw" or "Chi-Bálam xíw," "boca de la vieja." These names have also been used to refer to *A. angustifolia* and *A. ciliaris*.

Phenology.—Blooming from March to October.

Representative specimens examined: **MEXICO. Quintana Roo:** 4 km S of Puerto Morelos, *Téllez & Cabrera 3276* (F, MO, NY, US); Lázaro Cárdenas, El Edén Ecological Reserve, ca 20 km NW of Cancún, La Sabana near center of Preserve, 21°12.51'N, 87°11.64'W, 6 m, 27 Mar 1996, *Pitzer & Misquez 2548* (MO); Vallarta, 31 Aug 1980, *Souza, Téllez, & Cabrera 11201* (MEXU, MO). **Yucatán:** Maxcanú, Chunchucmil rumbo al rancho Sin-Kewel, 20°38'35"N, 90°12'41"W, 1 m, 10 Oct 1986, *Chan 7103* (MO); Maxcanú, 0–5 m, 10 Jun 1999, *Carnevali, May, & Tapia 5567* (MO); Dzemul, 30 Jun 1999, *Carnevali, et al. 5583* (MO); Progreso, 3–10 m, 21 Jun 2000, *Carnevali, Tapia, & May 5985* (MO); Dzemul, 2 km al S de entronque a las Ruinas de Xcambo, 21°18'00"N, 89°19'58"W, 7 Mar 2003, *Carnevali, Duno, and May 6743* (NY, MEXU, MO, XAL); 10–15 km N of Chuehuemi, *Darwin 2402* (TULANE); Progreso, *Floree s.n.* (F); Progreso, *Gaumer 1140* (F, GH, NY); Calotmul, *Gaumer 2198* (F, GH, MO, PH, US); Silam, *Gaumer 2199* (F); San Anselmo, *Gaumer 2200* (BM, F, K, P, W); Mérida road, Progreso, Jul 1938, *Lundell & Lundell 8028* (F, GH, NY, US); km 29 Mérida road, Progreso, *Lundell & Lundell 8031* (PH, US); Sisal to Mérida, *Schott 827* (F); near Sisal, *Schott 828* (MO, US); near Sisal, *Schott 917* (F); Merida, *Souza 256* (US); Progreso, *Steere 3034* (BM, F, MO, PH).

Angelonia parviflora is most easily distinguished from other *Angelonia* species by its small flowers and fruits. The flowers are 5 mm or less wide across the mouth and only 3 mm deep. The nectary sacs are relatively shallow at 1 mm deep. The fruits are 4–5 mm in diameter, about half the diameter of most other species. In addition, the species can be distinguished by the long, sparse glandular trichomes on the pedicels but these wear off and are usually present only at the base of the pedicels in older flowers and fruits.

Specimens of *Angelonia parviflora* have been identified as *A. angustifolia* Bentham, a species which is native to other parts of Mexico (Fig. 2), but which is often found in cultivation. *Angelonia angustifolia* differs in having glabrous pedicels, acuminate sepals 3–5 mm long, and capsules 7–10 mm in diameter. Its flowers are much larger; more than 7 mm across the mouth and 3–5 mm deep. *Angelonia ciliaris* B.L. Rob. can be found in southern Mexico, Belize, and Guatemala (Fig. 2) (Standley & Williams 1973) but, in addition to having larger flowers and fruits, that species has distinctive pubescent stems, leaves and pedicels.

The species of *Angelonia* growing in southern Mexico, Guatemala, and Belize can be difficult to distinguish, because they all have lanceolate leaves and blue or white flowers. South American species, not included in many keys for the region, have spread from cultivation making identifications more difficult. The following key distinguishes the species, both native and cultivated, that grow in the region.

KEY TO THE SPECIES OF *ANGELONIA* IN SOUTHERN MEXICO, GUATEMALA, AND BELIZE

1. Stem or inflorescence glandular-pubescent.
  2. Leaves to 4 cm long; upper corolla lobes 2–3 mm wide. Yucatán **A. parviflora** Barringer
  2. Leaves more than 4 cm long; upper corolla lobes more than 3 mm wide. South America (cultivated).
    3. Pedicels 2 per axil; sepals acute. E. Brazil (cultivated) **A. biflora** Benth.
    3. Pedicels 1 per axil; sepals acuminate.
      4. Capsules 10 mm diam.; lateral and median corolla lobes abaxially glabrous, bracts ovate to cordate Colombia and Venezuela (cultivated) **A. salicariifolia** Humb. & Bonpl.
      4. Capsules 6–8 mm diam.; lateral and median corolla lobes abaxially glandular-pubescent, bracts lanceolate; horn 2 mm long. E. Brazil (cultivated) **A. gardneri** Hook.f.
1. Stem or inflorescence eglandular pilose to glabrous.
  5. Sepals acuminate **A. angustifolia** Benth.
  5. Sepals acute, cuspidate.
    6. Pedicels pubescent; corolla tube 6–7 mm deep; stem and leaves densely pubescent. Belize, Guatemala, and Southern Mexico **A. ciliaris** B.L. Rob.

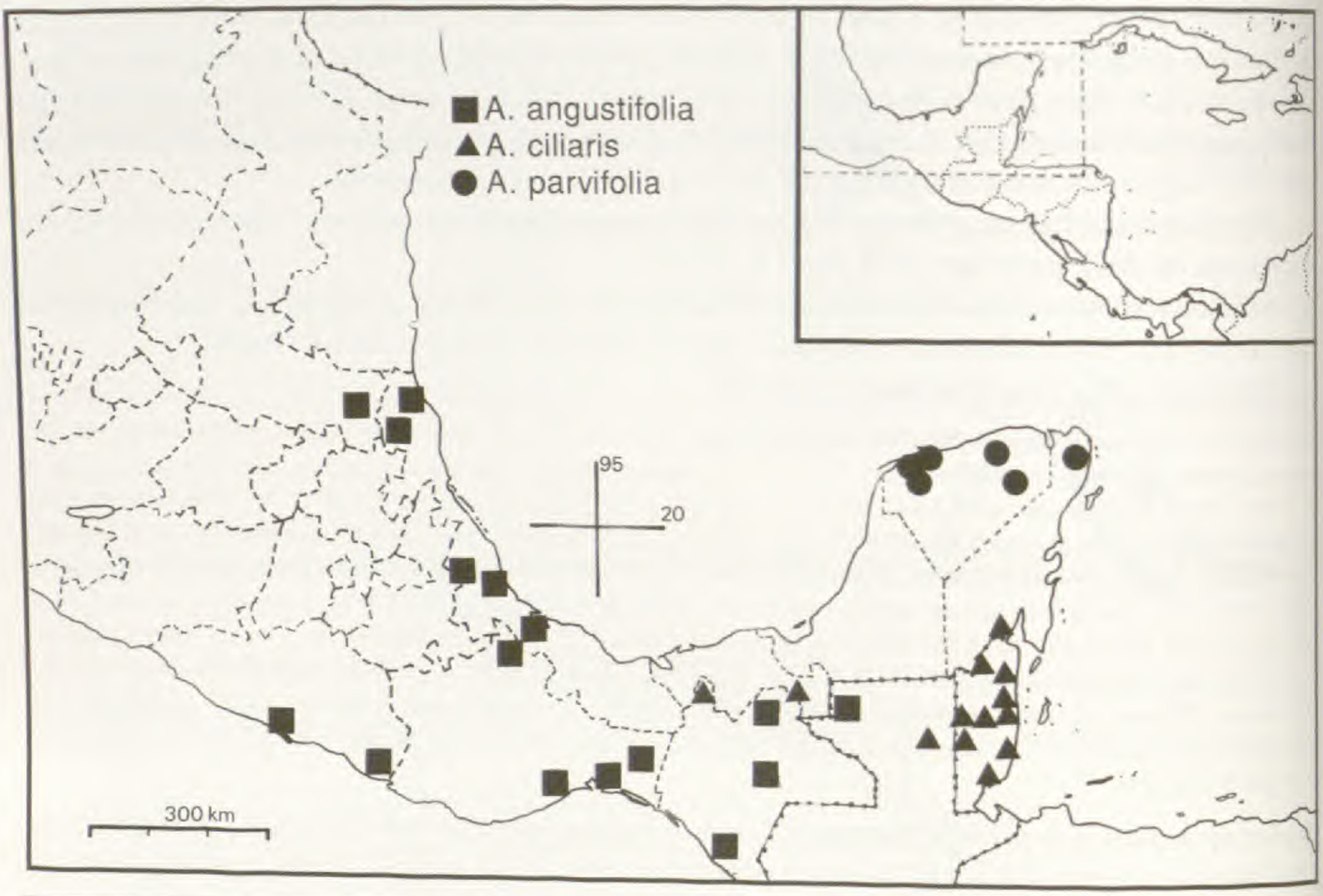

Fig. 2. Distribution of *Angelonia parviflora* compared to *Angelonia angustifolia* and *Angelonia ciliaris*.

6. Pedicels glabrous; corolla tube 9 mm deep; stem glabrous to slightly pubescent on the angles. Cuba and Jamaica ________ **A. pilosella** J. Kickx

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I thank Gregory Anderson, and William Crepet for their help with this research.I also want to acknowledge the help of the late Howard Pfeifer. Maarten Christenhusz was very helpful in checking the key and raised a number of interesting questions in discussions on the Mesoamerican scrophs. The careful reviews improved the manuscript and are gratefully acknowledged. I also thank the curators of A, BM, F, GH, K, MEXU, MO, NY, P, TEX, W, XAL, and US for allowing me to study the collections in their care. I am very grateful to Clara Richardson for the fine illustration.

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FOLIA TAXONOMICA 17. *DILKEA* (PASSIFLORACEAE) 2. CONSPECTUS OF THE SPECIES OF THE GUIANAS WITH THREE NEW SPECIES

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ABSTRACT

The conspectus lists six species of *Dilkea* (Passifloraceae) from the Guianas including three new species. Two new species of *Dilkea* subgenus *Dilkea* are described from the Guianas: **D. clarkei** from Guyana and **D. granvillei** from French Guiana; and one in subgenus *Epkia*, **D. exilis** from Amapá, Amazonas and Pará (Brazil) and French Guiana. A key to the Guianan species of *Dilkea* is provided.

RÉSUMÉ

Le conspectus liste six espèces de *Dilkea* (Passifloraceae) des Guyanes, y compris trois espèces nouvelles. Deux dans le sous-genre *Dilkea* sont décrites des Guyanes: **D. clarkei** de Guyana et **D. granvillei** de Guyane ; et une dans le sous-genre *Epkia*, **D. exilis** de l'Amapá, de l'Amazonas et du Pará (Brésil) et de Guyane. Une clé des espèces guyanaises de *Dilkea* est présentée.

The genus *Dilkea* Mast. can be separated easily from the other three genera of Passifloraceae from the western hemisphere. It has tetramerous flowers, versus pentamerous in *Passiflora* L. an androgynophore null to shorter than the ovary, versus well developed longer than the ovary in *Ancistrothyrsus* Harms, and 1 style with 4 branches 1/3 to 1/2 from base, versus 4 free styles in *Mitostemma* Mast. (Feuillet & MacDougal 2007). An introduction to *Dilkea* and a key to the subgenera can be found in Feuillet (2009).

In the text below, the word "lacking" means "not present in the taxon" and the expression "not seen" means "not present in the collections studies." In the descriptions, morphology and measurements between parentheses pertain to organs still growing.

A. Subgenus *Dilkea*

The species of *Dilkea* subg. *Dilkea* are sometimes low shrubs or treelets or mostly shrubs becoming lianas, climbing with tendrils that are trifid at apex. If the tendrils do not find a support, they are early deciduous, but otherwise become rigid and similar to twigs with respect to their diameter. The grabbing segment rolled around the support is usually swollen. In contrast with species of subg. *Epkia* Feuillet, those of subg. *Dilkea* have branches with internodes gradually increasing in length from the branching point, and their leaves are more or less regularly spaced, although rarely two are sub-opposite.

Subgenus *Dilkea* includes all the species described previous to 2009, but (see Feuillet 2009) not *D. johannesii* var. *parvifolia* Hoehne. Killip (1938) placed *D. ulei* Harms in the synonymy of *D. johannesii* Barb. Rodr. and everybody since then agreed with him. Although he suggested the genus might be monotypic, Killip kept four separate species—*D. acuminata* Mast. from Amazonas (Brazil), *D. johannesii* from Amazonas and Pará (Brazil), *D. retusa* Mast. from Amazonas (Brazil) and Loreto (Peru), that he selected as the type of the genus, and *D. wallisii* Mast. from Pará (Brazil, Loreto (Peru), and Amazonas (Venezuela) – and added one of his own, *D. parviflora* Killip from Loreto (Peru). Since then, the taxonomic history of *Dilkea* has been a series of various regroupings and a couple of new species. In 1968, *D. magnifica* Steyerm. was described. Holm-Nielsen et al. (1988) recognized *D. johannesii*, *D. parviflora*, and *D. retusa* (including *D. acuminata*, *D. magnifica*, and *D. wallisii*). In 1991, Cervi described *D. margaritae* from Mato Grosso (Brazil) and compared it to *D. acuminata* and *D. johannesii*. Tillett (2003) recognized as good species *D. acuminata* (including *D. johannesii* var. *parvifolia*, *D. magnifica*, and *D. parviflora*), and *D. retusa* differing by flower aestivation, but did

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not mention *D. johannesii* var. *johannesii*, *D. margaritae*, or *D. wallisii*. Tillett also stated that *Dilkea* included 7–9 species, implying that 2–4 species were undescribed. I am adopting a position rather close to Tillett's conclusions. The real problem is to deal with the numerous modern collections, especially from western Amazonia, which will be the subject of a latter paper.

1. Dilkea clarkei Feuillet, sp. nov. (**Fig. 1**). Type: GUYANA. Upper Takutu–Upper Essequibo: Kamoa Mts., 1°32'N, 58° 50'W, 520 m, 9 Nov 1996, fr, *H.D. Clarke 2987* (holotype: US; isotypes: BRG, CAY, K, MO, NY, P, VEN).

Haec ad subgenero *Dilkea* pertinens. A aliis speciebus, foliis coriaceis, ellipticis, 5–11 cm longis, fructibus sub-sphaericis, 2–3.5 cm, non apiculatis differt.

Liana climbing with thick, glabrous, axillary tendrils trifid at apex. Stems terete, glabrous, branches with short internodes and scales at basal 2–4 cm. Bud scales narrow-triangular, 5 × 1 mm, swollen at the very base, glabrous. Stipules reduced to U-shaped, shortly crenate-serrate rim around the base of the petiole, open apically, glabrous. Leaves alternate, occasionally subopposite; petiole canaliculate, 1–2.5 cm long, swollen at the base, glabrous; lamina coriaceous, elliptic, 5–11 × 4–7.5 cm cuneate at base, acuminate at apex, entire at margin, undulate when dry (probably due to the flattening of the leaf in the press), glabrous, 7–10 main veins on each side of the midrib. Inflorescences of solitary flowers at the axils of the first leaves of young stems. Flowers not seen. Fruits orange, globose, 2–3.5 cm diam., without basal and apical cones, with short to very short trichomes; seeds few, 15 × 10 × 7 mm, ovoid, slightly asymmetric, not to the point of having a flat or concave side, tapering at base, pedicel ca. 3 mm long.

Distribution and ecology.—Dilkea clarkei is known by two collections from the Upper Takutu–Upper Essequibo region of Guyana, at 250–520 m in forest on slope or summital scrub forest.

In subg. *Dilkea*, *D. clarkei* is unlike any other species because of the following characters. It has smaller, coriaceous, elliptic leaf blades and globose fruits that are neither tapering at base, nor hard apiculate.

Etymology.—Dilkea clarkei has been named in honor of H.D. Clarke, botanist (Univ. North Carolina at Asheville), an untiring collector of the Flora of Guyana who made the two collections of this new species known to me.

Paratypes: **GUYANA. Upper Takutu–Upper Essequibo:** Makawatta Massif, westernmost part, 3°5'24"N, 59°26'43"W, 250 m, 31 May 1996, fr., *H.D. Clarke 1848* (CAY, US).

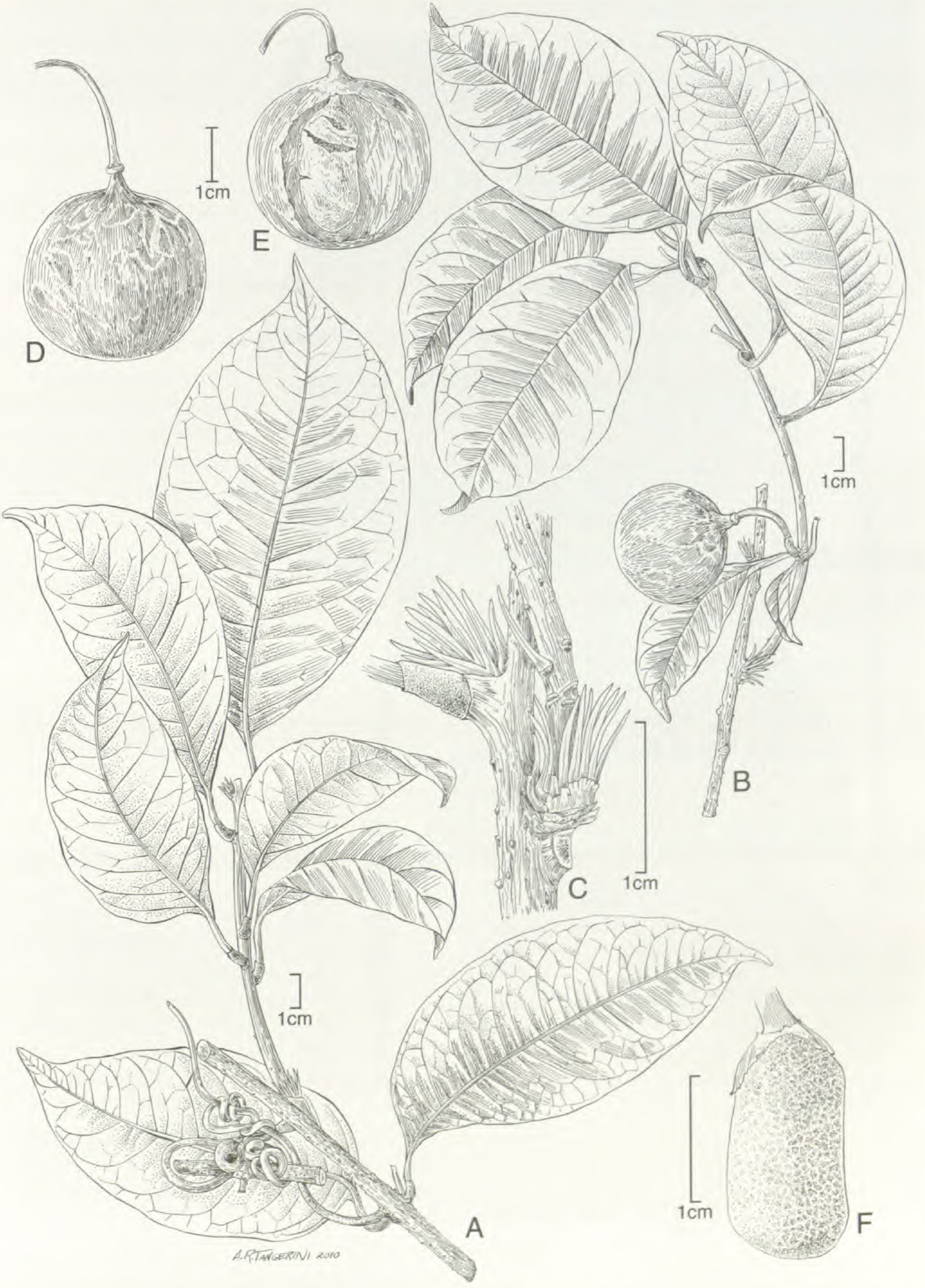
2. Dilkea granvillei Feuillet, sp. nov. (**Fig. 2**). Type: FRENCH GUIANA: Sommet des Monts Galbao, 10 km SE of Saül, 650 m, 9 Mar 1975, fr., *J.-J. de Granville 2398* (holotype: CAY (2 sheets)).

Haec ad subgenero *Dilkea* pertinens. A aliis speciebus, foliis chartaceis, oblanceolatis, (5–)13–18 cm longis, fructibus ellipsoideis vel obovoideis, 8 × 4 × 4 cm differt.

Woody climber; stems glabrous, axillary tendrils trifid at apex. Stems terete, glabrous, branches with short internodes and scales at basal 2–4 cm. Bud scales narrow-triangular, 5 × 1 mm, swollen at the very base, glabrous. Stipules fused in a U-shaped, shortly crenate-serrate rim around the base of the petiole, open apically, glabrous. Leaves alternate, sometimes subopposite; petiole canaliculate, (0.7–)2–2.5 cm long, glabrous, pulvinus less than a third of the total length; lamina chartaceous, (elliptic to) oblanceolate, (5–)13–18 × (3–)5.5–8 cm, (obtuse to) cuneate at base, rounded and with a 1–2 cm long acumen at apex, entire at margin, undulate when dry (probably due to the flattening of the leaf in the press), glabrous, 10–14 main veins on each side of the midrib. Inflorescences of solitary flowers in the leaf axils. Flowers not seen. Fruits pendent, orange with green spots, ellipsoidal to obovoid, 8 × 4 cm, shortly tapering at base, with a hardened apical cone, glabrous; seeds 10–15, 15 × 10 × 7 mm, ovoid, slightly asymmetric but not to the point of having a flat or concave side, tapering at base.

Distribution.—Dilkea granvillei is known only from the type locality on top of Mounts Galbao, near Saül, central French Guiana. It was fruiting in March and, according to the label of *de Granville 2398*, the seeds were germinating in the fruit.

In subg. *Dilkea*, *Dilkea granvillei* is unlike any other species because of the following characters. It has chartaceous, oblanceolate leaf blades and ellipsoid to obovoid fruits tapering at base and hard apiculate.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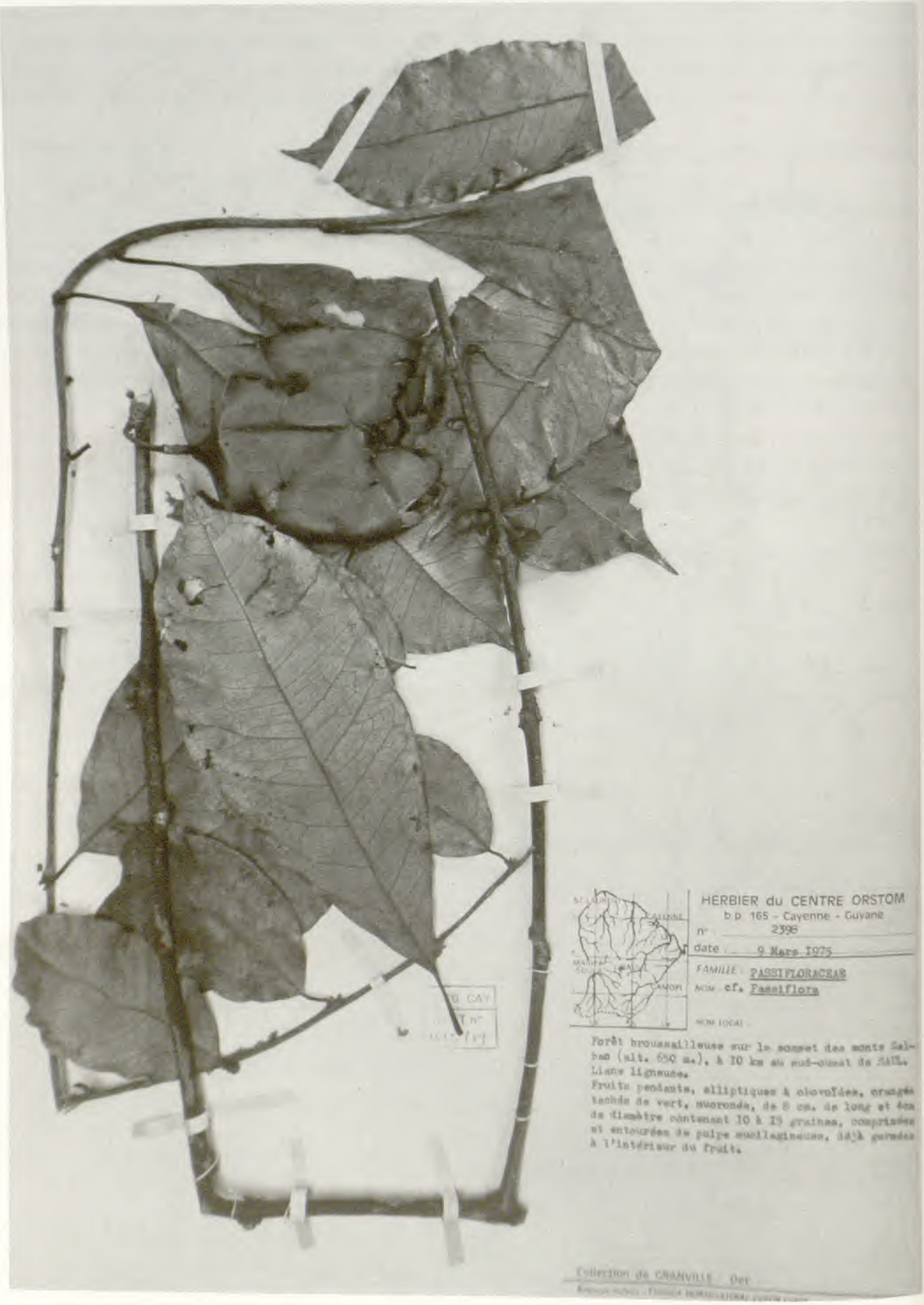
A.R.TANGERINI 2010

Fig. 1. *Dilkea clarkei*. **A.** Stem with leaves and tendrils; **B.** Stem with leaves and a fruit; **C.** Nodes showing the base of a branch and numerous bud scales; **D.** Fruit; **E.** Fruit open showing one of the seeds in the aril sac; **F.** Seed with only the base of the aril sac. A from *H.D. Clarke 1848* (US); B–F from type *H.D. Clarke 2987* (B, E–F: US; C–D: MO).



HERBIER du CENTRE ORSTOM
b.p. 165 - Cayenne - Guyane
n° 2398
date 9 Mars 1975
FAMILLE : PASSIFLORACEAE
NOM : cf. Passiflora
NOM LOCAL :

Forêt broussailleuse sur le sommet des monts Galbao (alt. 650 m.), à 10 km au sud-ouest de SAÜL. Liane ligneuse.

Fruits pendants, elliptiques à obovoïdes, orangés tachés de vert, mucronés, de 8 cm. de long et 4cm de diamètre contenant 10 à 15 graines, comprimées et entourées de pulpe mucilagineuse, déjà germées à l'intérieur du fruit.

Collection de GRANVILLE Det

Fig. 2. *Dilkea granvillei*, holotype *de Granville 2398* (CAY)

Etymology.—The epithet honors my friend and colleague, Jean-Jacques de Granville, former head of the botany department in Cayenne (CAY), French Guiana.

3. Dilkea retusa Mast., Trans. Linn. Soc. London 27:628. 1871. Type: BRAZIL. Amazonas: Manaus, Mar 1851, fl., *R. Spruce 1320*^{5} (holotype: K; photo BM, P, US).

?= *Dilkea acuminata* Mast., Trans. Linn. Soc. London 27:628. 1871. Type: BRAZIL. Amazonas: Manaus, Mar 1851, fl., *R. Spruce 1320*^{3} (holotype: K).

= *Dilkea wallisii* Mast, in Mart., Fl. Bras. 13(1):622; pl. 103, f. 3. 1872. Type: the cited illustration, drawn from a painting by Wallis (Brazil).

= *Dilkea magnifica* Steyerm, Acta Bot. Ven. 3:186. 1968. Type: VENEZUELA. Delta Amacuro: Sierra Imataca, Cerro La Paloma, E side of Río Cuyubini, 100–200 m, 18 Nov 1960, fl, *J.A. Steyermark 87606* (holotype: NY).

?= *Dilkea parviflora* Killip, Publ. Field Mus. Nat. Hist., Bot. Ser. 19:575. 1938. Type: PERU. Loreto: Mishuyacu, near Iquitos, 100 m, 2 Apr 1930, fl, *G. Klug 1158* (holotype: US; isotypes: F, NY).

Distribution.—From northern Amazonia and French Guiana and Venezuela to Bolivian Amazonia.

I am placing *D. parviflora* in the synonymy of *D. retusa*, along with *D. wallisii*, because the shape of the leaves on the type specimen from Peru is intermediary between the type of the other two, both from near Manaus (Brazil), but with some reluctance because the flowers of the type of *D. parviflora* are smaller. I am also hesitant to place *D. acuminata* in this synonymy because of the main veins are said by Killip (1938) to be much less ascending than Masters' illustration in *Flora Brasiliensis* (1871). If that were confirmed, *D. acuminata* could be a separate species or the correct name for *D. johannesii* and *D. ulei*.

Specimens examined: **BOLIVIA. Beni:** 2 km NW of Guayaramerin, 19 Feb 1978, fl, *W.R. Anderson 12120* (INPA). **BRAZIL. Amazonas:** Munic. Itapiranga, Rio Uatumã, 27 Aug 1979, fl, *C.A. Cid, W.R. Buck, B.W. Nelson, F. Almeida, C.D.A. Mota & J. Lima 861* (INPA); Road Manaus – Boa Vista, 60°08'W, 02°27'N, 150 m, 27 Feb 1976, fl, *P. Bamps 5447* (BR); **Pará:** Belem, 3 Apr 1926, fl, *A. Ducke* s.n. (BR-21307); **Rondônia:** Rodovia Presidente Médici-Alvorada, Rio Muqui, 18 Jun 1983, fr., *M.G. Silva 6218* (MG, US). **COLOMBIA. Valle:** Munic. Buenaventura, 76°58'W, 04°02'N, 30–50 m, 18 May 1989, fr, *D.C. Daly, R. Callejas & M. Monsalve 6036* (NY, US); **Vaupés:** Río Inírida, Raudal Guacamayo, 69°45'W, 4 Feb 1953, fr, *A. Fernández 2124* (COL, US). **FRENCH GUIANA:** Approuague River, about 4.5 km upstream from Pierrette, 9 Jun 1966, fr, *R.A.A. Oldeman B-541* (CAY); Arataye River, Inselberg des Nouragues, 52°42'W, 4°03'N, 30 Oct 1993, fl., *Poncy 937* (CAY, P, U, US); Arataye River, Montagne des Nouragues, 52°42'W, 4°3'N, 260 m, 2 Apr. 1992, fl. Bud & fr., *Larpin 1028* (CAY); Counami, 53°15'W, 05°21'N, 22 Mar 2000, fl, *J.-F. Molino & D. Sabatier 1979* (CAY, P, US); Massif du Décou-Décou, near Citron, 580 m, 13 Nov 1982, fl., *C. Feuillet 368* (BR, CAY, P, U, US); Montagne des Nouragues, 52°42'W, 04°03'N, Feb 1990, fl, *D. Larpin 861* (CAY(2), US); Montagnes de la Trinité, N summit, 400 m, 12 Jan 1984, fl., *de Granville et al. 5908* (CAY); Near Saül, between Eaux Claires and St. Éloi, 53°12'W, 03°37'N, ca. 250 m, 18 Sep 1994 fl, *S.A. Mori, C. Snyder & R. Fowler 23957* (NY, US); Route de l'Est (RN 2), Montagne Maripa, 10 May 1979, fl, *J.-J. de Granville 2884* (CAY, US). **PERU. Loreto:** Gamitanococha, Río Mazán, 100–125 m, 12 Feb 1935, fl, *J.M. Schunke 233* (P, US). **VENEZUELA. Amazonas:** Rio Negro, San Carlos, about 100 m, 28–29 Jan 1930, fl, *E.G. Holt & W. Gehriger 292* (US); **Bolívar:** Río Asa, Raudal Maturin, 63°19'W, 06°22'N, 13 May–13 Jun 1987, bud & fr, *B. Stergios 11218* (PORT, US).

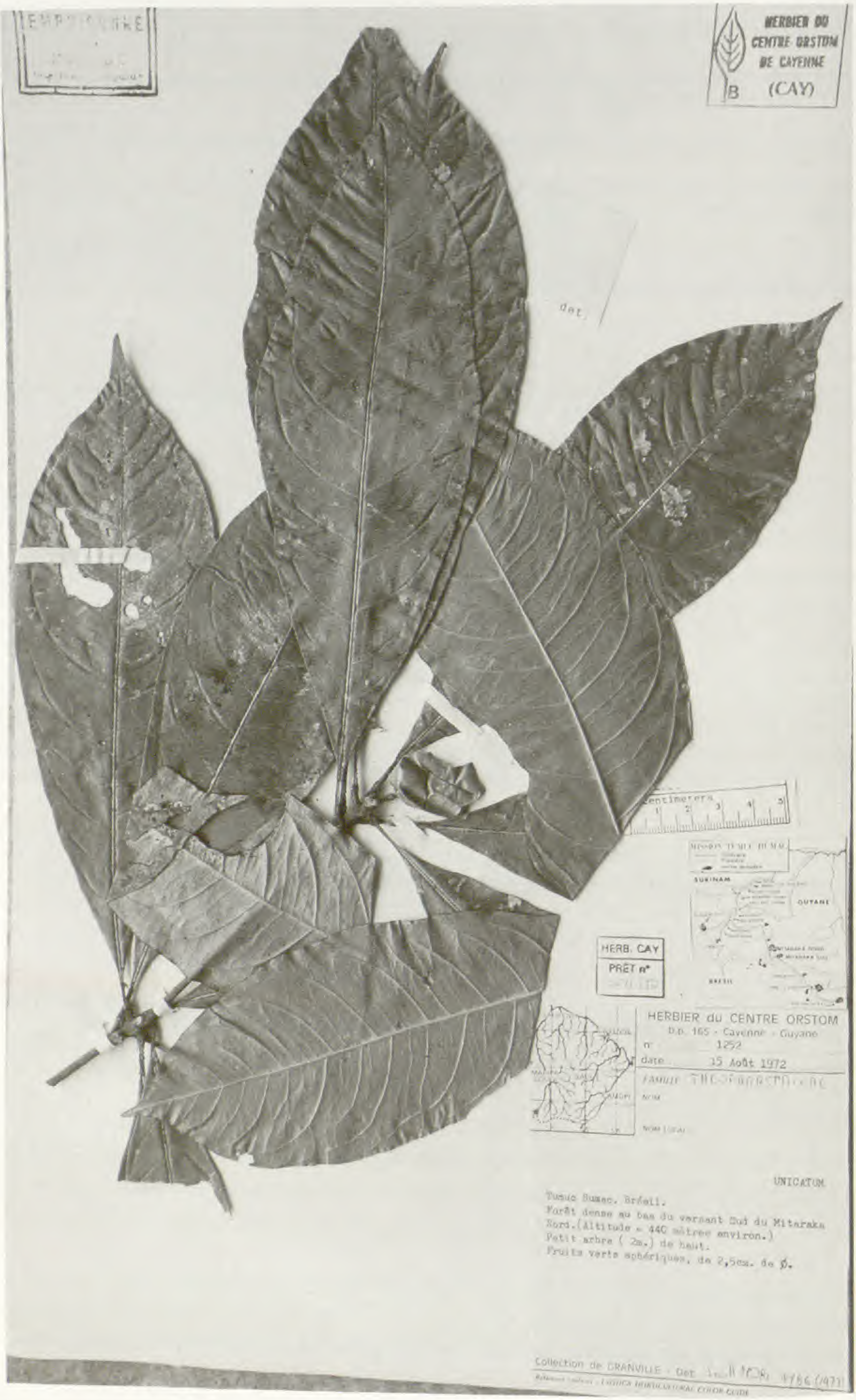
B. Subgenus *Epkia*

For an introduction to *Dilkea* subg. *Epkia* see Feuillet (2009).

4. Dilkea exilis Feuillet, sp. nov. (**Fig. 3**). Type: BRAZIL. Amapá: Serra de Navio, Igarapé Pedra Preta, 22 Nov 1954, fr., *R.S. Cowan 38505* (holotype: NY).

Haec ad subgenero *Epkia* pertinens. Petiolus parte non-tumida 0.8–2.4 cm longa, lamina foliorum membranacea vel chartacea, 14–30 × 3.7–9 cm, cuneata differt.

Shrubs or small trees 1.5–8 m tall. Whole plant glabrous. Stems with a long internode 3–9 cm long, followed by short ones about as long as once their diameter or less. Bud scales linear about 2 mm long. Tendrils lacking. Stipules not seen. Leaves mostly in terminal clusters; petiole (1.5–)2–3.2 cm long, including the pulvinus 0.7–1.6 cm long, glands not seen; blade narrow oblanceolate, cuneate, (14–)17–30 × (3.7–)5–9 cm, long attenuate, apex acute, acuminate, margin entire, drying dark olive adaxially and yellowish olive abaxially, midrib and veins raised on both surfaces and yellowish when dry, 10–15 main veins on each side of the midrib. Inflorescences subterminal; pedicels 6–14 mm long under the fruits. Flowers not seen; gynophore 2–4 mm long under the fruit. Fruits spherical, apex conical, 5 cm diam., yellow to pale yellow, pericarp coriaceous, about 0.5 mm thick; seeds the shape of peanuts, 14 × 6 mm.


HERBIER DU CENTRE ORSTOM DE CAYENNE
B (CAY)
det.
Centimeters
1 2 3 4 5
SURINAM
GUYANE
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HERBIER du CENTRE ORSTOM
b.p. 165 - Cayenne - Guyane
n° 1252
date 15 Août 1972
FAMILLE
NOM
NOM LOCAL
UNICATUM
Tumuc Humac. Brésil.
Forêt dense au bas du versant Sud du Mitaraka
Nord. (Altitude = 440 mètres environ.)
Petit arbre (2m.) de haut.
Fruits verts sphériques, de 2,5cm. de Ø.
Collection de GRANVILLE - Det
HORTICULTURAL COLOR GUIDE

Fig. 3. *Dilkea exilis,* paratype *de Granville 1252* (CAY)

Distribution.—Dilkea exilis is known from northern and western Amazonia from the Oyapock River, the border between French Guiana and Amapá (Brazil), to Pará and Amazonas (Brazil).

Dilkea exilis can be recognized easily from other species of subg. *Epkia* by the combination of the following characters. Its leaves have petioles up to 3 cm long with a short pulvinus and blades with a thin texture, and fruits spherical, not tapering at base, but with a hard conical apex.

Etymology.—The specific adjective *exilis*, meaning thin in Latin, refers to the leaf blades of that species that are membranaceous on dried herbarium specimens.

PARATYPES. **BRAZIL. Amapá:** Oyapock River, Brazilian bank, between Oiapoque and Clevelandia, 19 Jul 1960, fr, *B. Maguire, J.M. Pires & C.K. Maguire 47077* (MO, NY n.v.); S slope of Mt Mitaraka North, 440 m, 15 Aug 1972, fr, *J.-J. de Granville 1252* (CAY, CAY); **Amazonas:** BR 230, Rod. Transamazônica, 303 km from Humaitá, Munic. Novo Aripuanã, near Rio Aripuanã, 07°35'S, 60°40'W, 27 Apr 1985, fr., *C.A. Cid Ferreira 5850* (INPA n.v., MO, NY n.v.); **Pará:** Munic. Oriximiná, Rio Trombetas, Lago Erepecu, 18 Jul 1980, fr, *C.A. Cid, J. Ramos, C.D.A. Mota & N. Rosas 1673* (INPA n.v., MO). **FRENCH GUIANA:** Arataye River, Saut Pararé, 11 Oct 1980, fr (*fide sched.*), *D. Sabatier 5* (CAY, CAY).

5. Dilkea lecta Feuillet, J. Bot. Res. Inst. Texas 3:597, fig. 2, 25 Nov 2009. TYPE: FRENCH GUIANA: near Organabo, primary forest on white-sand, 20 Jun 1995, fr., *D. Loubry 2422* (HOLOTYPE: US; ISOTYPES: CAY, MPU).

=? *Dilkea johannesii* var. *parvifolia* Hoehne, Comm. Linh. Tel. Matto Grosso ao Amazonas, Annexo 5, Bot. pt. 5:73; pl. 111. 1915. TYPE: BRAZIL. MATO GROSSO: Rio Juruena, *Comm. Linh. Tel. Matto Grosso Expedition 5433* (SP).

Distribution.—Dilkea lecta is known from the Lely Mountains in eastern Surinam, from central and northwestern French Guiana, and from Mato Grosso (Brazil).

6. Dilkea vanessae Feuillet, J. Bot. Res. Inst. Texas 3:602, fig. 5, 25 Nov 2009. TYPE: FRENCH GUIANA. Pic Matecho, camp near the summit, 500 m, 14–15 Dec 2000, fr., *V. Hequet 1000* (HOLOTYPE: US; ISOTYPE: CAY).

Distribution.—The only known collections were made in the rainforest, on Pic Matecho and Montagne des Nouragues, granitic outcrops in central French Guiana. They were fruiting in November and December.

KEY TO THE SPECIES OF *DILKEA* IN THE GUIANAS

1. Main stem growth continuous, leaves scattered along the branches ____ **subg. Dilkea**
  2. Leaf blades membranous or chartaceous ____ **D. granvillei**
  2. Leaf blades coriaceous.
    3. Leaf blades elliptic, 5–11 × 4–7.5 cm ____ **D. clarkei**
    3. Leaf blades elliptic to obovate or oblanceolate, 15–28 × (5–)7–14 cm ____ **D. retusa**
1. Main stem growth rhythmic, branches' growth units with a long internode and the leaves aggregated at the apex ____ **subg. Epkia**
  4. Petioles reduced to its swollen curved base or nearly so; leaf blades narrow-oblanceolate, 9–14.5 × 1.7–3.5 cm ____ **D. lecta**
  4. Petioles with a straight thin portion clearly visible above its swollen curved base.
    5. Leaf blades coriaceous, with 7–9 main veins each side of the midrib ____ **D. vanessae**
    5. Leaf blades membranous to chartaceous, with 10–15 main veins each side of the midrib ____ **D. exilis**

ACKNOWLEDGMENTS

I would like to thank Paul Hiepko (B) and Shawn Krosnick (RSA) for their reviews of this paper. This work could not have been completed without the help of the curators of the herbaria AAU, CAY, MO, NY, and P who hosted me in their institution or made available to me the material in their care. This is number 164 in the Smithsonian's Biological Diversity of the Guiana Shield Program publication series.

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MILIUSA WAYANADICA (ANNONACEAE), A NEW SPECIES FROM WESTERN GHATS, INDIA

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KINGDOM OF SAUDI ARABIA

ABSTRACT

A new species of *Miliusa* Lesch. ex A. DC. (Annonaceae) allied to *M. indica*, sect. *Miliusa*, is described and illustrated from the Western Ghats of India.

RESUMEN

Se describe y se ilustra una nueva especie de *Miliusa* Lesch. ex A. DC. (Annonaceae) emp arentada con *M. indica*, sect. *Miliusa*, de Western Ghats en la India.

INTRODUCTION

The genus *Miliusa* Lesch. ex A. DC. is currently recognized with 40 species mostly of Austral-Asiatic ranges from India, Sri Lanka, and Bhutan to Australia through the Malayan islands (Mols & Keßler 2003). Ten species are reported from the Austro-Malesian area (Mols & Keßler 2003), 33 species from continental Asia (Tanawat, pers. comm.), and three species from Sri Lanka (Huber 1985). In India the genus is represented by 15 species distributed mainly in western and northeastern regions and Andaman and Nicobar Islands (Mitra 1993). Western Ghats is an important center of *Miliusa* in Peninsular India. Six species of *Miliusa* are reported from Kerala (Sasidharan 2007). Ramamurthy (1983) reported five species from Tamil Nadu. Recently, a new species was described from the Kalakkad-Mundanthurai Tiger Reserve of Tamil Nadu (Murugan et al. 2004). Five species of *Miliusa* are known from Karnataka (Saldanha 1984; Sharma et al. 1984). Among the 15 species in India, four species are endemic to Western Ghats (Mitra 1993; Murugan et al. 2004). This includes the red listed *Miliusa nilagirica* Bedd. (IUCN 2006).

Wayanad district in Kerala is unique. The entire area is along the Western Ghats with altitudes ranging from 700 m to 2100 m msl. During our floristic exploration in the forests of Wayanad, some specimens of *Miliusa* collected from the hilltops of Meppady and Kalpetta Forest Ranges were strikingly different from other species of *Miliusa*, due to their recurved petals. On critical study with the available literature and comparison with authentic specimens, it is confirmed that the material does not match with any previously described species. Therefore it is described and illustrated here as a new species.

Finet and Gagnepain (1906) recognized two sections in the genus viz, sect. *Saccopetalum* (Benn) Finet & Gagnep. and sect. *Miliusa*. Mols and Keßler (2003) did not refer to these sections in their revisionary studies of *Miliusa* in the Austro-Malesian area. However, Huber (1985) followed this categorization in his treatement for *A revised Handbook to the Flora of Ceylon*. These sections were solely based on the number of ovules. Section *Saccopetalum* is characterized by a minimum number of four ovules and sect. *Miliusa* is characterized by a maximum of two ovules. Earlier these two sections were recognized as separate genera. Following Finet and Gagnepain (1906), our species belongs to the sect. *Miliusa* due to the 1–2-ovuled carpels and is resembles to *Miliusa indica* with intermediate characters of *M. nilagirica*. Van Heusden (1992) studied morphology,

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classification, and evolution of flowers in Annonaceae and described the flower morphology in the *Miliusa* group. He did not mention anything about the recurved nature of inner petals in Miliusoid flowers. This peculiarity is not only a unique character of *Miliusa wayanadica* but also a novelty in the genus itself.

Miliusa wayanadica Sujanapal, Ratheesh & Sasidharan, sp. nov. (**Figs. 1–2**). TYPE: INDIA. KERALA. Wayanad district: Kurichiarmala, N 11° 35.769'E 75° 58.787' ±1092 m, 20 Feb 2002, *N Sasidharan & M.K. Ratheesh Narayanan MSSH 2642* (HOLOTYPE: MH; ISOTYPES: CAL, CALI, KFRI, Herb. MSSRF, Kalpetta, Wayanad).

Miliusae indicae sectionis Miliusae similis foliis subsessilibus elliptico-lanceolatis ad lanceolatis, infra: nervis pubescentibus, flore axillari solitario, carpello ampulliformi ovulis 1 vel 2, sed folii basi obliqua, sepalis late ovatis, petalis interioribus recurvatis adaxialiter pilosis, staminibus minus numero, carpellis glabris differt.

Miliusa wayanadica (sect. *Miliusa*) is similar to *M. indica* in its axillary, solitary flowers, 1–2-ovuled, flask-shaped carpels, and subsessile, hairy-nerved, elliptic-lanceolate or lanceolate leaves. But it differs in its oblique leaf bases, broadly ovate sepals, recurved inner petals with hairs on the abaxial side, fewer stamens, and glabrous carpels.

Shrubs to small trees, to 7 m height; bark black, branches terete, branching horizontal, young parts densely pubescent. Leaves simple, alternate, 6–9 × 2–3 cm, lanceolate or elliptic-lanceolate, base rounded, slightly oblique, apex caudate acuminate, petiole to 3 mm or subsessile, coriaceous, lateral nerves 5–8 pairs, intramarginal nerves sub-marginal, tomentose on both sides, margins entire. Flowers yellow or yellowish-green, solitary, axillary or slightly above the axil, pedicel 4–7 mm long, glabrous, bracteoles two at the base, unequal, triangular, very small; sepals 3, ca. 4 × 3 mm, broadly ovate; outer petals 3, triangular, ca. 3 mm long, slightly curved on mature flower, prominently hairy on margins; inner petals 3, broadly ovate, 7–9 × 2–4 mm, upper half out-curved at 90°, hairy on the mouth; torus triangular, long hairy, stamens 6+3, anthers in pairs, staminodes 3, arranged alternate with two stamens, one pair slightly above the staminode, connective slightly prolonged above the anther, connective truncate, anthers extrorse; carpels 7–12, flask shaped, 2 mm long, glabrous, stigma club-shaped, with viscous exudation on the torus in mature flower, ovules 1 or 2. Monocarps 6–8, subglobose, glabrous, brownish or blackish when dry, apiculate; stipe terete, 10–13 mm long, stalk of monocarps ca. 5 mm, monocarp 8–10 mm across; seeds 1 or 2.

PARATYPES: **INDIA. KERALA. Wayanad district:** Kurichiarmala, N 11°35.769'E 75°58.787' ±1100 m, 20 Feb 2002, *M.K. Ratheesh Narayanan MSSH2642*; 18 Jul 2007, *Ibid., M.K. Ratheesh Narayanan MSSH4050*; Kalladi-900 forest N 11°30.716'E 76°06.239' ±899 m, 12 Feb 2004, *M.K. Ratheesh Narayanan MSSH4371*; *Ibid.*, Jun 2007, *M.K. Ratheesh Narayanan & P Sujanapal MSSH3600*; *Ibid.*, Aug 2007, *M.K. Ratheesh Narayanan MSSH3367*; Kattimattam, N 11°30.127'E 76°08.110' ±1049 m, 12 Mar 2006, *M.K. Ratheesh Narayanan & P Sujanapal MSSH2896* (All in Herb. MSSRF, Kalpetta, Wayanad)

Flowering and fruiting.—Flowering starts from December and peak time is March. More flowers were observed on the exposed lower branches. Occasional flowering was observed outside this season, especially in the non-rainy season.

Etymology.—The specific epithet denotes the locality, a unique area with diverse topographical peculiarities and a Hot Spot of Biodiversity in the Western Ghats.

Distribution and status.—Small populations of this species were observed in two locations in Wayanad. At Kurichiarmala of Kalpetta Forest Range few individuals were observed. Kalladi forest areas in Meppadi Forest Range the population is comparatively large with small tree-sized individuals.

Habitat and conservation.—Evergreen forests between 800 m to 1400 m asl is the most common habitat of the new species. It is mostly seen along the sides of streams as a lower stratum tree or shrub. *Miliusa nilagirica* is also found in the same habitat. Other Annonaceae species in the habitat are *Desmos lawii* (Hook. f. & Thoms.) Safford, *Meiogyne ramarowii* (Dunn) Gandhi, and *Orophea sivarajanii* N. Sasidharan. The other tree associates in the habitats are *Agrostistachys borneensis* Becc., *Dimocarpus longan* Lour., *Drypetes venusta* (Wight) Pax & K. Hoffm., *Epiprinus mallotiformis* (Müll.-Arg.) Croizat, *Holigarna ferruginea* Marchand, *Euonymus indicus* Heyne ex Roxb., *Hydnocarpus alpina* Wight, *Myristica beddomei* King, *Palaquium ellipticum* (Dalz.) Baill., *Paracroton pendulus* (Hassk.) Miq. ssp. *zeylanicus* (Thwaites) N.P. Balakr. & Chakrab., etc. In all the locations, population size of this new species is small. None of the localities of distribution is under any protected areas.

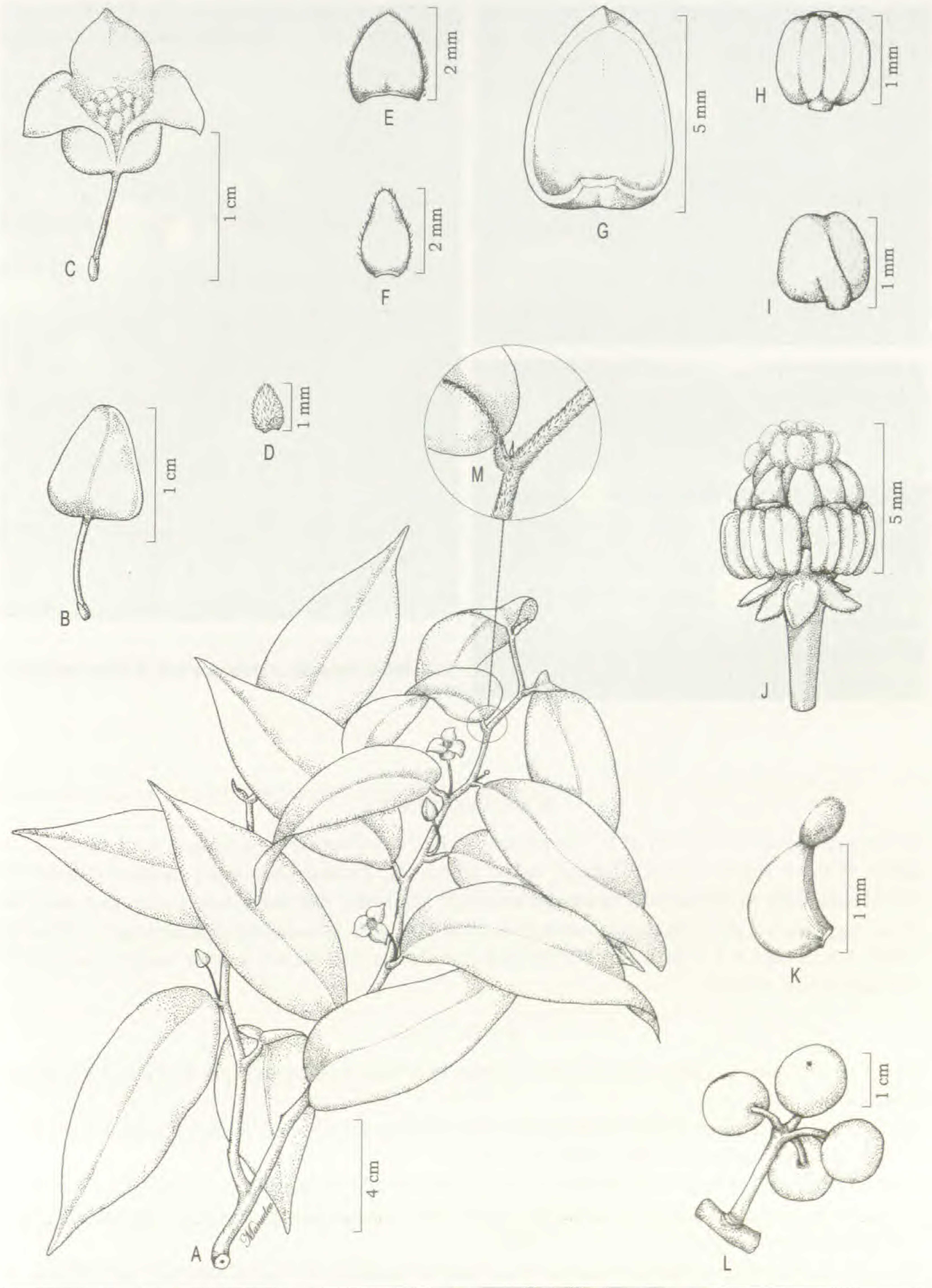
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Fig. 1. *Miliusa wayanadica.* **A.** Flowering twig; **B.** Flower bud; **C.** Flower; **D.** Bracteole; **E.** Sepal; **F.** Outer petal; **G.** Inner petal; **H.** Stamen-Ventral view; **I.** Stamen-Dorsal view; **J.** Flower with petal removed; **K.** Pistil; **L.** Fruit; **M.** Leaf node enlarged.

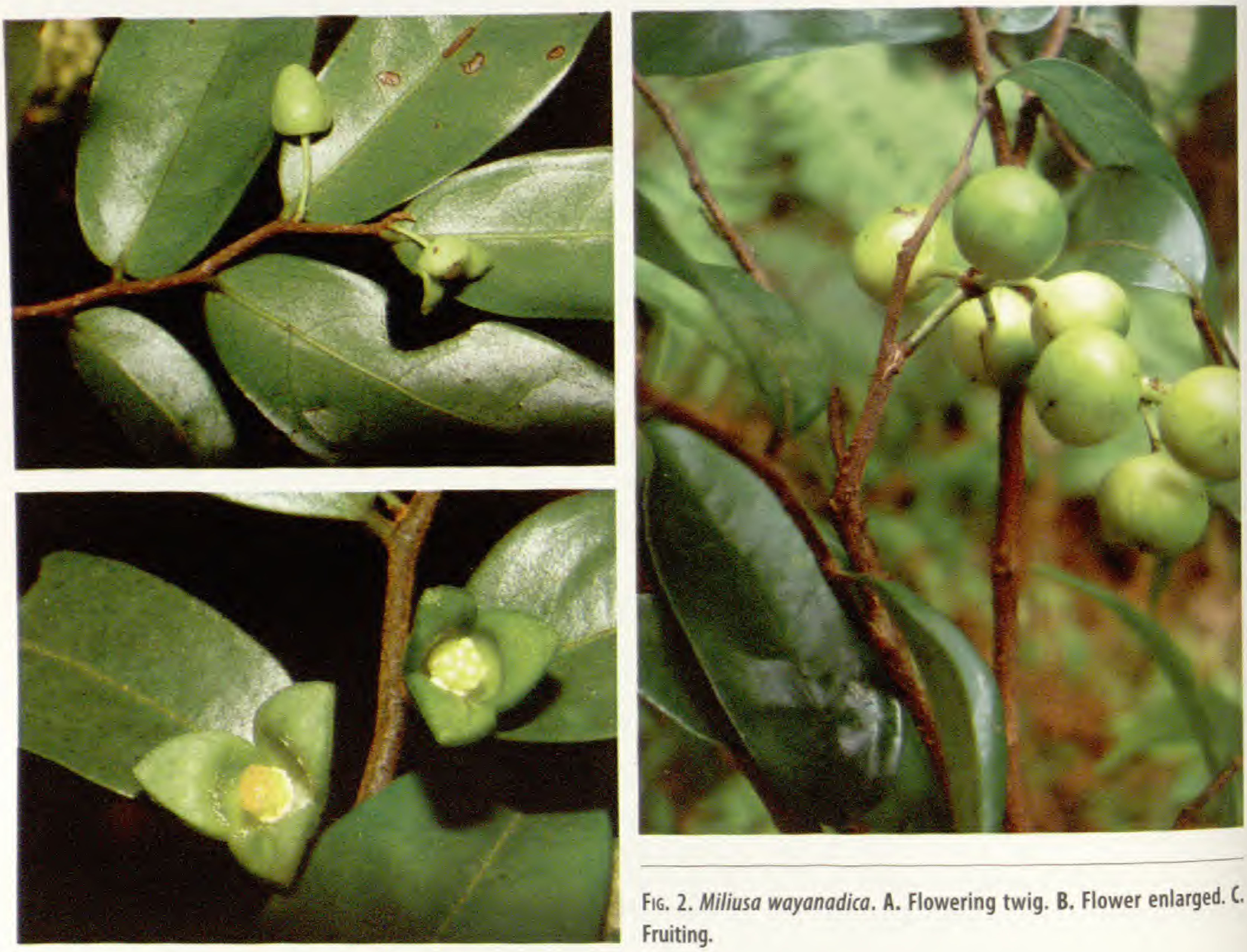

Fig. 2. ***Miliusa wayanadica*. A. Flowering twig. B. Flower enlarged. C. Fruiting.**

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BOOK REVIEW

Dorothy Green. 2007. **Managing Water: Avoiding a Crisis in California**. (ISBN 978-0-520-25327-8, pbk.) University of California Press, 2120 Berkeley Way, Berkeley, CA 94704-1012, U.S.A. (**Orders:** orders@cpfsinc.com or www.ucpress.edu, 510-642-4247, 510-643-7127 fax). $27.95, 336 pp., 6" × 9".

Water is a resource that, in this country until somewhat recently, was taken for granted by many. Such is not the case in the 21st century. Many areas are painfully aware of the precious nature of this commodity. California is one of those areas. The author, Dorothy Green, takes a look at water problems of highly populated Los Angeles County and extends that to the state level. This book delivers a thorough look at all the intricacies of water politics: water sources, management agencies, water use efficiency, and water quality. The five chapters of the book are amply smattered with pie charts, tables, and graphs and are written in a clear and fact oriented style. Each chapter then ends with a conclusion section where the author states her view of the situation. This is not a book just for Californians but anyone in the US. Even if you feel your state has no water issues, it will.—*Robert J George, Botanical Research Institute of Texas, 500 E 4th St., Fort Worth, Texas, 76102-4025, U.S.A.*

From the publisher: "**Dorothy Green** is founding president of Heal the Bay and among the founders of the Los Angeles and San Gabriel Rivers Watershed Council, of which she is also president emeritus. She has chaired the California Water Policy (POWER) conference for the past 17 years and has helped to found the only non-profit in the state, the California Water Impact Network (c-win.org), totally devoted to water supply issues."

STYLIDIUM DARWINII (STYLIDIACEAE), A NEW TRIGGER PLANT FROM WESTERN GHATS OF KARNATAKA, INDIA

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ABSTRACT

A new species of Stylidiaceae viz., **Stylidium darwinii** Punekar & Lakshmin. is described from Western Ghats of Karnataka, India with illustrations, photographs, and a key to the Indian species of *Stylidium* provided.

RESUMEN

Se describe una nueva especie para la ciencia de la familia Stylidiaceae viz., **Stylidium darwinii** Punekar & Lakshmin. colectada en la parte occidental de Ghats Karnataka, India, así mismo se proporcionan ilustraciones, fotografías y una clave para la identificación de las especies del género *Stylidium*.

INTRODUCTION

The genus *Stylidium* Sw. consists of ca. 300 species distributed in Southeast Asia, Australia and New Zealand (Juliet Wege pers. comm. 2009). In India, the genus comprises two species (Santapau & Henry 1973; Mitra et al. 1998) viz., *S. kunthii* Wall. ex DC. and *S. tenellum* Sw. of which the former is distributed in India (Uttarakhand, Assam, West Bengal, Orissa, Bihar, Madhya Pradesh), Bangladesh, Myanmar, Vietnam, Thailand and Java, and the latter in India (Uttar Pradesh, Bihar, West Bengal, Orissa, Madhya Pradesh, Maharashtra, Karnataka, Tamil Nadu), Bangladesh, Laos, Myanmar, Kampuchia, Thailand, Vietnam, Sumatra and Malaysia (Mitra et al. 1998).

During the course of botanical exploration of Anshi National Park in Karnataka (Punekar ined. 2007), interesting specimens of *Stylidium* were collected. After a perusal of the literature and comparison with herbarium collections at BSI & CAL as well as our own field observations, the specimens were found to be quite distinct from other known species of *Stylidium* and hence are described herein as a new species. The new species belongs to subgenus *Andersonia* (R.Br. ex G. Don) Mildbr. A key to the Indian species of *Stylidium* is also provided for easy identification.

Stylidium darwinii Punekar & Lakshmin., sp. nov. (**Figs. 1, 2A–E**). TYPE: INDIA. KARNATAKA. Uttara Kannada District: Anshi-Ulvi road near Nature Camp, Anshi National Park, 15°00.67 N, 74°23.68 E, 530 m, 24 Sep 2003, *Punekar* 187782 (HOLOTYPE: CAL; ISOTYPES: BSI).

Stylidium darwinii Punekar & Lakshmin. sp. nov. *S. kunthii*, *S. inconspicuo* & *S. tenello* affinis. A *S. kunthii* caule glabro (non sparsim glanduloso-pubescenti), foliis omnibus caulinis atque secus caulem dispersis (non vulgo foliis rosulis terminalibus, aliquot caulem dispersis), corolla violaceo-rosea (non alba vel rosea), segmentis corollae anticis ovatis vel deltoideis (non oblongis nec lanceolatis), segmentis corollae posticis ad apicem retusis vel subretusis (non emarginatis) differt. A *S. inconspicuo* foliis minoribus 2–3 × 1.5–1.8 mm (non 4–8 × 2–5 mm), corolla parce glanduloso-hirsuta (non glabra), appendicibus faucis manifestis (nec vix manifestis), segmentis corollae anticis ad apicem subacutis vel acutis (non bilobatis vel integris, obtusis ad apicem), segmentis corollae posticis ad apicem retusis vel subretusis (non bifidis) differt. A *S. tenello*, segmentis corollae anticis ovatis vel deltoideis (non lanceolatis nec oblongo-lanceolatis), segmentis corollae posticis minoribus 0.8–1 × 0.5–0.7 mm (non 2.1–3.3 × 1–1.3 mm) ad apicem retusis vel subretusis (non profunde bifidis), columna ca. 2.5 mm longa (non 4–5 mm longa), timida ad medium (non latiduinis uniformis omnino) differt.

Small, erect annual, herbs, up to 4.5 cm high. Stem simple, glabrous, dark brown to copper brown with few leaves. Leaves scattered, alternate, subsessile, 2–3 × 1.5–1.8 mm, elliptic-oblong or obovate to orbicular,

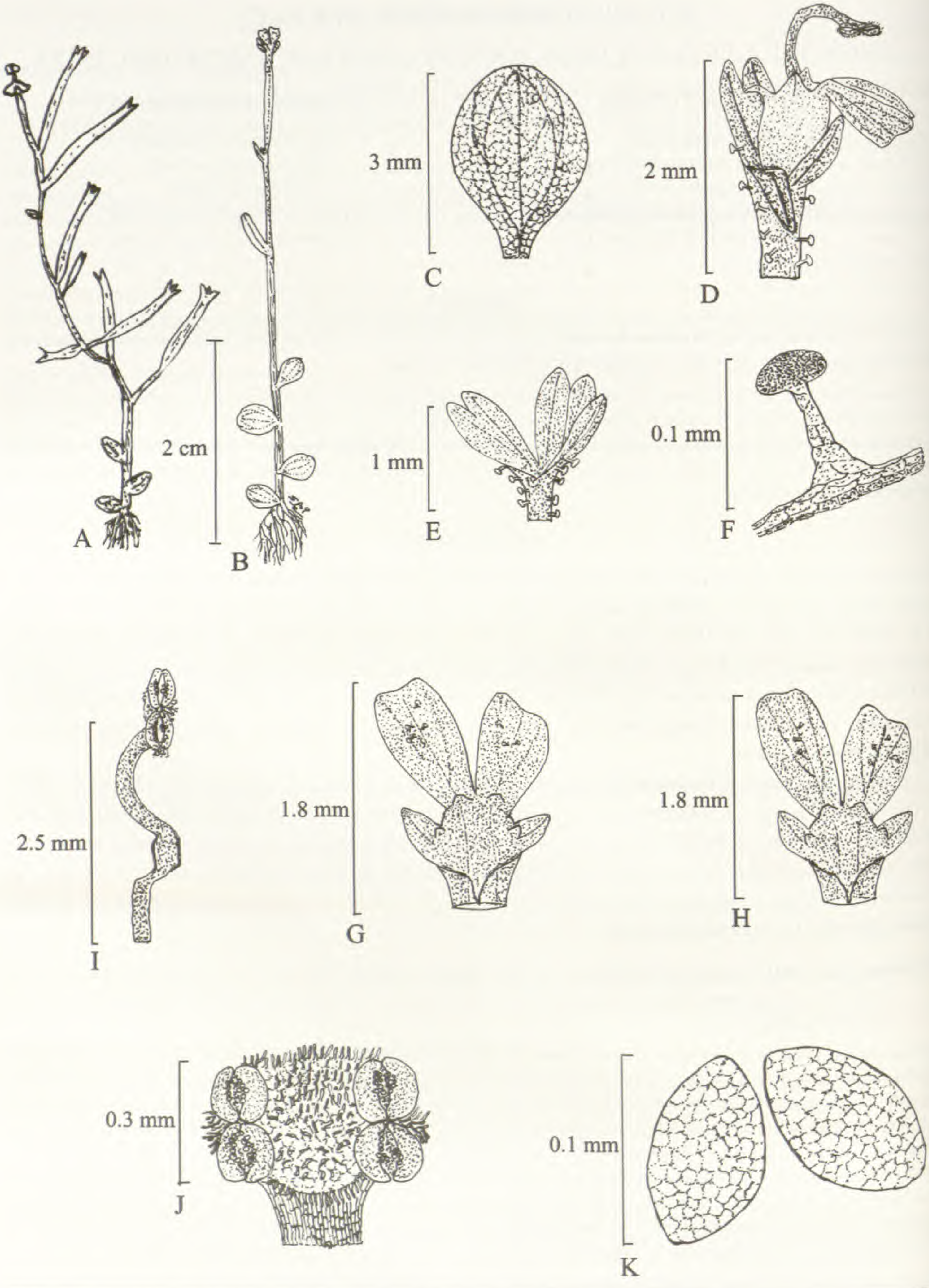
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Fig. 1. *Stylidium darwinii* Punekar & Lakshmin. **A–B.** Habit; **C.** Leaf; **D.** Flower; **E.** Calyx; **F.** Glandular hair on calyx; **G–H.** Corolla; **I.** Column (lateral view); **J.** Part enlarged of column showing stamens and stigma; **K.** Seeds. (Drawn by Sachin A. Punekar). Voucher no. *Punekar 187782 & 698*.

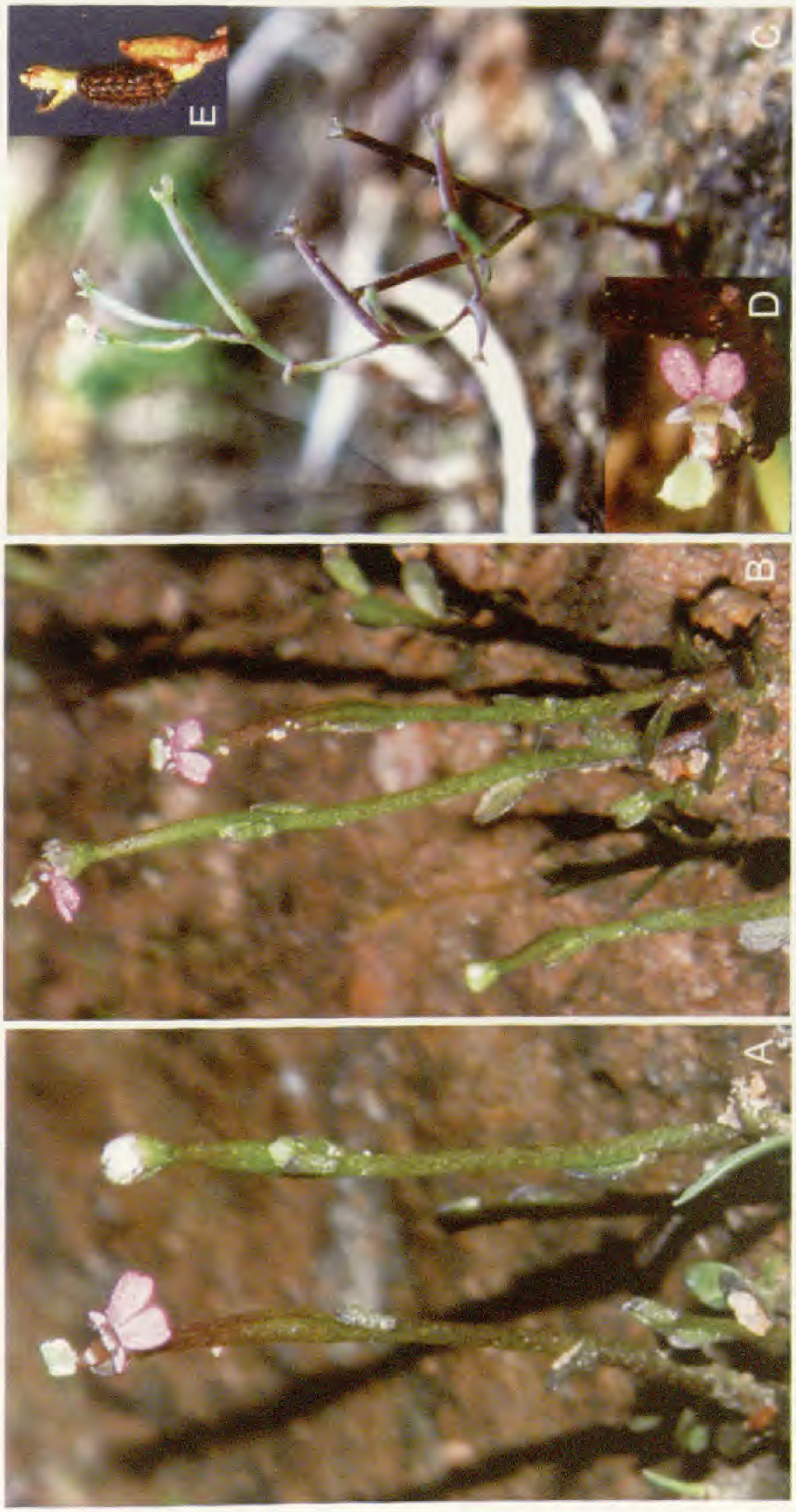

Fig. 2. *Stylidium darwinii* Punekar & Lakshmin. A–C. Flowering and fruiting habit. D. Flower – upper view. E. Insect caterpillar feeding on plant (Photos by Sachin A. Punekar). Voucher nos. *Punekar 187782 & 698.*

greenish-red, fleshy, apex obtuse-rounded, 3-nerved. Inflorescence 1-many-flowered; bracts ca. 1.6 × 0.6 mm, oblong, green, fleshy, obtuse and red at apex, 1-nerved. Flowers very small, sessile. Calyx tube (hypanthium) with glandular hairs distally; lobes 5, elliptic, 1-nerved, green, obtuse and red at apex, the 2 anterior ones connate into bifid lobe, ca. 1.4 × 0.5 mm, posterior 3 free, ca. 1 × 0.5 mm. Corolla violet-pink, sparingly glandular hairy; tube short, hyaline, ca. 1 mm long, with appendages on the throat; appendages 4, small, deltoid (one at the base of each corolla segment); segments free, posterior ones 0.8–1 × 0.5–0.7 mm, obovate, retuse to subretuse at apex, glandular hairy, usually 1–3-nerved; anterior segments much smaller, 0.4 × 0.15–0.2 mm, ovate to deltoid, subacute to acute at apex, 1-nerved; labellum very small, hyaline, usually 0.2–0.3 mm, rarely 0.5 mm long, subulate or subdeltoid, acuminate to subacute at apex, 1-nerved. Column much exserted ca. 2.5 mm long, geniculate, swollen and pink in middle, rest hyaline. Stamens 2, lateral, sessile, connate with style; anthers 2-celled, extrorse, anther thecae ca. 0.3 × 0.15 mm, ovoid, pale yellow, dehiscing apically by a slit, pollen grains ovoid. Ovary inferior, ca. 5 mm long, 2-celled, with many ovules; stigma entire, greenish, hairy. Capsules linear, up to 1 cm long, dehiscent. Seeds very small, ca. 0.1 mm long, ovoid, brownish.

Stylidium darwinii Punekar & Lakshmin. is allied to *S. kunthii* Wall. ex DC., *S. inconspicuum* Slooten, a species endemic to Java (Slooten 1954; Bean 2000), and *S. tenellum* Sw. *Stylidium darwinii* differs from *S. kunthii* in having glabrous stem (vs. sparsely glandular pubescent), leaves cauline and scattered all over the stem (vs. leaves mostly in terminal rosette, with some scattered along stems), corolla violet-pink (vs. white or pink), anterior corolla segments ovate to deltoid (vs. oblong to lanceolate) and posterior corolla segments retuse to subretuse at apex (vs. emarginate). *Stylidium darwinii* differs from *S. inconspicuum* in having smaller leaves, 2–3 × 1.5–1.8 mm (vs. bigger leaves 4–8 × 2–5 mm), corolla sparingly glandular hairy (vs. corolla glabrous), appendages clear on the throat (vs. appendages on the throat hardly visible), posterior corolla segments retuse to subretuse at apex (vs. bifid) and anterior corolla segments subacute to acute at apex (vs. bilobed or entire, obtuse at apex). *Stylidium darwinii* differs from a most akin species *S. tenellum* in having anterior corolla segments ovate to deltoid (vs. lanceolate to oblong-lanceolate), posterior corolla segments smaller, 0.8–1 × 0.5–0.7 mm (vs. longer, 2.1–3.3 × 1.1–1.3 mm), retuse to subretuse at apex (vs. deeply bifid), column ca. 2.5 mm long, swollen in the middle (vs. 4–5 mm long, of uniform width throughout).

Bean (2000)—in the revision on the *Stylidium* subg. *Andersonia* (R.Br. ex G. Don) Mildbr.—treated many taxa as synonyms under *Stylidium tenellum* such as *Stylidium roseum* Kurz (Type: Chittagong, Bangladesh), *S. tenellum* var. *minimum* C.B. Clarke (Type: Chota Nagpur at Hazaribagh) and *Epilobium tonkinense* H. Lév. (Type: Tonkin near Quang-Yen, Vietnam). These synonyms are nothing but a size variant of *S. tenellum* especially considering the height of the plant and number of flowers, but none of them differ in floral morphology. The newly proposed species *S. darwinii* is compared with that of Bean's description for *S. tenellum* which covers the entire length of variation of *S. tenellum* and its synonyms. Mildbraed (1908), Erickson (1958) and Mitra et al. (1998) also treated *S. roseum* as a synonym of *S. tenellum*, while Mitra et al. (1998) in their treatise on the genus *Stylidium* of India for the first time considered *S. tenellum* var. *minimum* as a synonym of *S. tenellum*.

The only available classification of *Stylidium* is that of the German botanist Mildbraed (1908). On the basis of habit and floral morphology *S. darwinii* is currently best placed in subgenus *Andersonia* (R.Br. ex G. Don) Mildbr. until a formal revision of the infrageneric taxonomy of *Stylidium* is completed.

Distribution.—This species is known only from Anshi National Park, Uttara Kannada (North Kanara) District of Karnataka State, India.

Habitat and Ecology.—Rare in the outskirts of evergreen forest near roadsides at an elevation of 530 m above mean sea level in moist gravelly soil near monsoon puddles in association with *Drosera burmannii*, *D. indica*, *Eriocaulon achiton*, *E. lanceolatum*, *E. truncatum*, *E. xeranthemum*, *Fimbristylus* spp., *Lindernia crustacea*, *L. hyssopioides*, *Lobelia alsinoides*, *Utricularia caerulea*, *U. minutissima* and *U. naikii*. Insect caterpillar probably a Lepidopteran was observed feeding the flower parts.

Flowering and Fruiting.—September–November.

Etymology.—The specific epithet "*darwinii*" is after Charles Robert Darwin, who is well known for his publication of *Origin of Species by Means of Natural Selection*.

PARATYPES: **INDIA. Maharashtra. Uttara Kannada District:** Anshi National Park, 15°00.67 N, 074°23.68 E, 530 m, 28 Sep 2004, *Punekar* 388 (MACSG); same locality, 24 Nov 2009, *Punekar* 698 (AHMA, MACSG).

KEY TO THE INDIAN SPECIES OF *STYLIDIUM*

1. Leaves strictly cauline, scattered all over stems.
    2. Posterior corolla segment retuse to subretuse at apex; anterior corolla segments ovate to deltoid ______ **S. darwinii**

2. Posterior corolla segment deeply bifid at apex; anterior corolla segments lanceolate to oblong-lanceolate ________ **S. tenellum**

1. Leaves mostly in terminal rosette, with some scattered along stems ________ **S. kunthii**

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The authors are grateful to the Directors of Agharkar Research Institute, Pune and Botanical Survey of India, Kolkata for facilities. One of us (SAP) is thankful to the Joint Director, Botanical Survey of India, Western Circle, Pune, and K.P.N. Kumaran, Agharkar Research Institute, Pune for encouragement and Karnataka Forest Department for granting permission for undertaking field studies in Anshi National Park, Karnataka. Help rendered by Katherine Challis and Wilmot-Dear (Melanie Thomas), Royal Botanic Gardens, Kew, and M.K. Vasudeva Rao, Ex–Joint Director, Botanical Survey of India, Pune for the Latin diagnosis is gratefully acknowledged. Thanks are also due to Lourdes Rico, Royal Botanic Gardens, Kew for the Spanish abstract. We thank Juliet Wege, E.S. Santhosh Kumar, and an anonymous reviewer for providing helpful suggestions. Thanks are also due to Robert Vogt and Marion Cubr, Botanic Garden and Botanical Museum Berlin-Dahlem, Freie Universität Berlin, Berlin, Curator and V.P. Prasad, Indian Liaison Officer, Royal Botanic Gardens, Kew, Adele Smith, Royal Botanic Garden, Edinburgh, Curator and Sovanmoly Hul, Muséum National d'Histoire Naturelle, Paris, M.S. Mondal, and S.K. Srivastava, Central National Herbarium, Howrah, for sending the scanned type images and microfiche of *Stylidium tenellum* and its synonyms and various other species.

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BOOK REVIEW

JOSEPH ARDITTI. 2008. **Micropropagation of Orchids, 2nd Edition.** (ISBN 978-1-4051-6088-9, hbk.). Blackwell Publishing, Ltd., 350 Main Street, Malden, Massachusetts 02148-5020, U.S.A. (**Orders:** www.wiley.com; available in alternate format of Adobe E-Book). $495.00, 1560 pp., 9 lbs total, each volume 10" × 8".

This title comes as two separate hardcover volumes, attractively housed together within a 5-sided cardboard casing that matches the volume covers. This second edition expands and updates material registered in the first edition, which was published in 1993 by Wiley and Sons and covered orchid micropropagation methods published between 1974 and 1990 within 682 pages. The second edition boasts another 878 pages, accounting for the large increase in methods published across the years 1990 and 2000. Reviewers' comments indicate that this publication continues to be a primary resource for this discipline. Below are the short contents from each volume, as well as the orchid genera treated and supplementary materials, such as appendices.—*Tiana F. Franklin, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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Inflorescences
A Patent
Doubtful Claims
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Darkening of Culture Media
Anticontaminants
Cell and Protoplast Culture
Flowering in Vitro
The Future
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Preparation of the Medium
Culture Vessels
Culture Conditions
Placing Plant Material in Culture
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Work Area
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STUDIES IN CAPPARACEAE XXVII: SIX NEW TAXA AND A NEW COMBINATION IN *QUADRELLA*

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ABSTRACT

Six new taxa and one new combination are newly established within the genus *Quadrella* (DC.) J. Presl (Capparaceae s.s.) from the Dominican Republic and Central America. (1) *Quadrella alaineana* Cornejo & Iltis, a new rare endemic from Azua in the Dominican Republic; (2) *Quadrella dressleri* Cornejo & Iltis, a second detritophilous taxon described from eastern Panama; (3) *Q. incana* var. *triangularis* Cornejo & Iltis, a new variety endemic to coastal Jalisco, Mexico; (4) *Q. incana* subsp. *yucatanensis* (Lundell) Iltis, a new combination, centered on the Yucatán Peninsula, Mexico; (5) *Q. lindeniana* Cornejo & Iltis, a new species from Quintana Roo, Mexico and endemic to the Yucatán Peninsula; (6) *Q. morenoi* Cornejo & Iltis, a new species described from Nicaragua where it is common, but distributed from southwestern Mexico to northern Costa Rica; and (7) *Q. morenoi* forma *hastata* Iltis, a juvenile form. Within the Capparaceae, the genus *Quadrella* now includes 25 species, 9 subspecies and a variety known from across Mesoamerica and the West Indies.

Key Words: *Quadrella*, Capparaceae, Mesoamerica, West Indies, IUCN Red List

RESUMEN

Se establecen seis nuevas taxa y una nueva combinación perteneciente al género *Quadrella* (DC.) J. Presl (Capparaceae s.s.), distribuidas en la República Dominicana y América Central. (1) *Quadrella alaineana* Cornejo & Iltis, una rara especie endémica de Azua, en la República Dominicana; (2) *Quadrella dressleri* Cornejo & Iltis, un segundo taxón detritófilo del este de Panamá; (3) *Quadrella incana* var. *triangularis* Cornejo & Iltis, una nueva variedad endémica de la costa de Jalisco, Méjico; (4) *Quadrella incana* subsp. *yucatanensis* (Lundell) Iltis, una nueva combinación, esta subespecie se encuentra centrada en la Península de Yucatán, Méjico; (5) *Q. lindeniana* Cornejo & Iltis, una nueva especie endémica de Quintana Roo, en la Península de Yucatán, Méjico; (6) *Q. morenoi* Cornejo & Iltis, una nueva especie descrita para Nicaragua donde es común, y distribuida desde el suroccidente de Méjico hasta el norte de Costa Rica; (7) *Q. morenoi* forma *hastata* Iltis, una forma juvenil. En Capparaceae s.s., el género *Quadrella* ahora está constituido por 25 species, 9 subespecies y una variedad, distribuidas a lo largo de Mesoamérica y las Indias Occidentales.

Quadrella (DC.) J. Presl (Capparaceae s.s.), is an American genus that now comprises 25 species, 9 subspecies and 1 variety. It is centered on the lands surrounding the Caribbean Sea, from western Mexico to Panama and from Florida and the Bahamas through the West Indies to northern Colombia and Venezuela (Iltis & Cornejo 2010 a, b). The six new taxa we discovered during our revision of *Quadrella* for a treatment of Capparaceae for Flora Mesoamericana (in prep.); are described as follows.

1. Quadrella alaineana Cornejo & Iltis, sp. nov. (**Fig. 1**). Type: DOMINICAN REPUBLIC [Hispaniola]. Azua: Monte Río Azua, sandy soil, in thickets, 22 Aug 1964 (fl), *Bro. Basilio Augusto Lavastre 1730* (holotype: JBSD; isotypes: NY, WIS).

Species *Quadrella domingensie* (Spreng. ex DC.) Iltis & Cornejo et *Q. ferrugineae* (L.) Iltis & Cornejo affinis, a qua differt sepalis grandior, 5–7 × 1.5–2.5 mm (vs. 1–5 [–6] × 0.5–1 mm), oblongis et valvatis; gynophoris longioribus, 6–9 mm longus (vs. 1–5 mm).

Shrubs ca. 2 m tall, slender and much branched, evergreen, pubescent throughout, with dense, short, delicately branched candelabra trichomes with yellowish brown centers and whitish arms. Leaves alternate to spirally arranged; petioles 0.6–1.5 cm, canaliculate; blades conduplicate when young, at maturity ovate to elliptic or slightly obovate, 3.4–8 × 1.3–3.7 cm, thinly coriaceous or chartaceous, dull, green to brownish, densely white-stellate and glabrescent, leaving adaxially abundant, microscopic dark to light dots, light green or brown abaxially, with abundant short candelabra trichomes not soft to the touch; apex acute to obtuse or rounded and minutely apiculate, sometimes emarginate, the base rounded, truncate to inconspicuously retuse; lateral veins 7 to 10 pairs, upwardly arching, the tertiary veins laxly reticulate, both prominent

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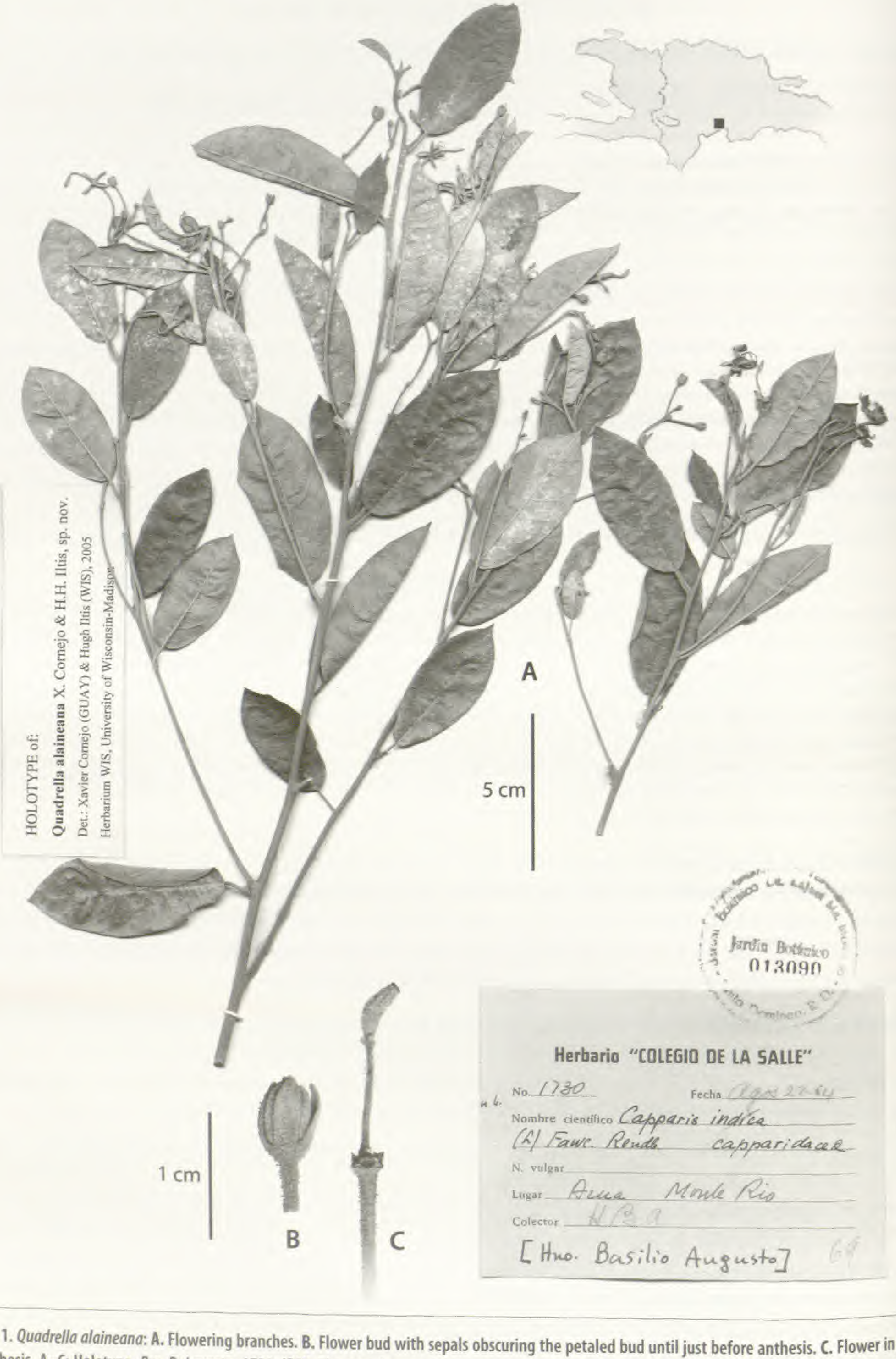

HOLOTYPE of:
Quadrella alaineana X. Cornejo & H.H. Iltis, sp. nov.
Det.: Xavier Cornejo (GUAY) & Hugh Iltis (WIS), 2005
Herbarium WIS, University of Wisconsin-Madison
A
5 cm
Jardín Botánico
013090
Herbario "COLEGIO DE LA SALLE"
No. 1730
Fecha
Nombre científico Capparis indica
(L) Fawc. Rendl. capparidaceae
N. vulgar
Lugar Azua Monte Rio
Colector H B A
[Hno. Basilio Augusto]
1 cm
B
C

FIG. 1. *Quadrella alaineana*: **A.** Flowering branches. **B.** Flower bud with sepals obscuring the petaled bud until just before anthesis. **C.** Flower in postanthesis. A–C: Holotype, *Bro. B. Lavastre 1730*, JBSD. The map (upper right) indicates the location of Azua Province on Hispaniola in the Dominican Republic, wherein exist the only known stations.

abaxially. Inflorescences at terminal branchlets, openly corymbose-racemose, encrusted with short candelabra trichomes; peduncles ± complanate, 2–6(–7.5) cm, bearing 2 to 5 flowers, with only one open at a time; floral bracts linear, 2–3 mm, soon deciduous; pedicels 1.5–2.7 cm, densely candelabroid pubescent. Sepals 1-seriate, covering the petals in bud nearly to anthesis, oblong, 5–7 × 1.5–2.5 mm, widely spreading to sharply reflexed at anthesis, densely encrusted with short brownish candelabra trichomes adaxially and abaxially, each sepal subtending a basally pubescent gland, 0.3–1 × 1.2–2 mm; petals ovate, 7–8.5 × 4–5 mm, white, costate and densely pubescent abaxially, veined and glabrous adaxially; stamens 8, the filaments ca. 8 mm, stellate or candelabroid pubescent at base, the anthers ca. 2 mm; androgynophores ca. 0.8 mm, glabrous; gynophores 6–9 mm, the ovaries oblong-ellipsoid, ca. 3 × 1 mm, both densely covered by short, whitish candelabra trichomes, the stigma truncate. Fruits unknown.

The rare *Quadrella alaineana*, with all four collections gathered at presumably the same general locale in Azua province over a period of some 51 years, has had a confused taxonomic history. Recognized as rare and distinct from the softly and densely pubescent *Q. grisebachii* (= *Q. domingensis* subsp. *grisebachii* [Eichler] Iltis) on the basis of the two (mixed) *Rose et al.* paratypes in NY by that great student of the Hispaniola flora, Bro. Alain (E.E. Lioger), who, in a long letter to Iltis of Jan. 16, 1968, made it quite clear that he believed these NY *Q. alaineana* specimens to represent *Q. domingensis* (and which Alain then thus so annotated in NY) and that the *Q. grisebachii* specimens were a totally different species. Unfortunately, Bro. Alain never saw Bertero's type for *Q. domingensis* from Azua, Hispaniola (of which WIS has a single leaf and a photocopy of the type ex M), which would have suggested that: 1) *Q. grisebachii* was a synonym, or at best a subspecies, of *Q. domingensis* (cf. Rankin & Greuter 2004: 263; Iltis & Cornejo 2007); and 2), that the two *Rose et al.* paratypes (*3903* and *4405*) were indeed a very different and undescribed endemic taxon from Azua. This is one of the most arid localities in the Dominican Republic, and a biodiversity hot spot of local endemism, to which we now add still another species.

Although the fruits and seeds of *Quadrella alaineana* are unknown, the presence of candelabra trichomes and flowers with eight stamens indicate that this species belong to *Quadrella* subg. *Intutis* (Rafinesque) Iltis (Iltis & Cornejo 2010b).

IUCN.—Due to the lack of recent collections of *Quadrella alaineana* and deforestation in Azua, this species is categorized as endangered, EN B2ab(iii).

Etymology.—In the afore-mentioned letter to the second author, Brother Alain outlined his future plans to recollect his "*Q. domingensis*," which he says "...seems to be restricted to the very dry Azua region...," a plan, which he never was able to fulfill. It is a pleasure, therefore, to name this new species in honor of that great lover of Hispaniola's flora, who had the acuity to realize that this Azua population was different and unique.

PARATYPES: **DOMINICAN REPUBLIC. Azua:** 14 Mar 1913, *J. Rose, W. Fitch & P. Russell 3903*, p.p. (B [not seen], NY, US, US fragm. at WIS); Mar 1913, *J.J. Rose, W. Fitch & P. Russell 4405* (NY, US); Las Charcas, s.d., *J. Jiménez s.n.* (NY, USD [not seen]).

2. Quadrella dressleri Cornejo & Iltis, sp. nov. (**Figs. 2–3**). TYPE: PANAMA. PANAMA: 8–12 km N of El Llano along new El Llano-Cartí road, in premontane wet forest, 400–450 m, 12 Dec 1973 (fl), *M. Nee, A. Gentry & R. Dressler 8765* (HOLOTYPE: WIS; ISOTYPES: MO, US, PMA, WIS [2]).

Species detritofila affinis *Quadrella antonensis* (Woodson) Iltis & Cornejo, a qua differt arbor parva plerumque monocaulis, foliis longioribus, (25–)30–70 × 8–20 cm (vs. [12–]15–35[–40] × 3–10[–11] cm), cum basis cordatis, inflorescentiis aphyllis disticho-ramosae paniculiformiis cum bracteis distichis persistentibus, subulatis, 3–4 mm longis, et ad 50 racemis subcorimbosis, solum 1 vel 2 interim, uterque cum 2 ad 8 floris, postquam brevi tempore decidua; petalis 7–8 mm longis.

Usually unbranched or sometimes 2-branched, slender treelets, 1 to 4 m tall, densely brown lepidote to stellate throughout. Crown leaves often very large, densely and tightly clustered, spirally arranged, upwardly pointing and basally overlapping into in a detritus-collecting funnel 50–130 cm across; petioles 0.8–2 cm, canaliculate, usually obscured by adventitious rootlets and half-decomposed leaf debris; leaf blades lepidote-stellate to stellate when young, broadly oblanceolate to oblong when mature, (25–)30–70 × 8–20 cm, dark green and glabrescent, with hairs leaving abundant minute pinholes adaxially, light green with

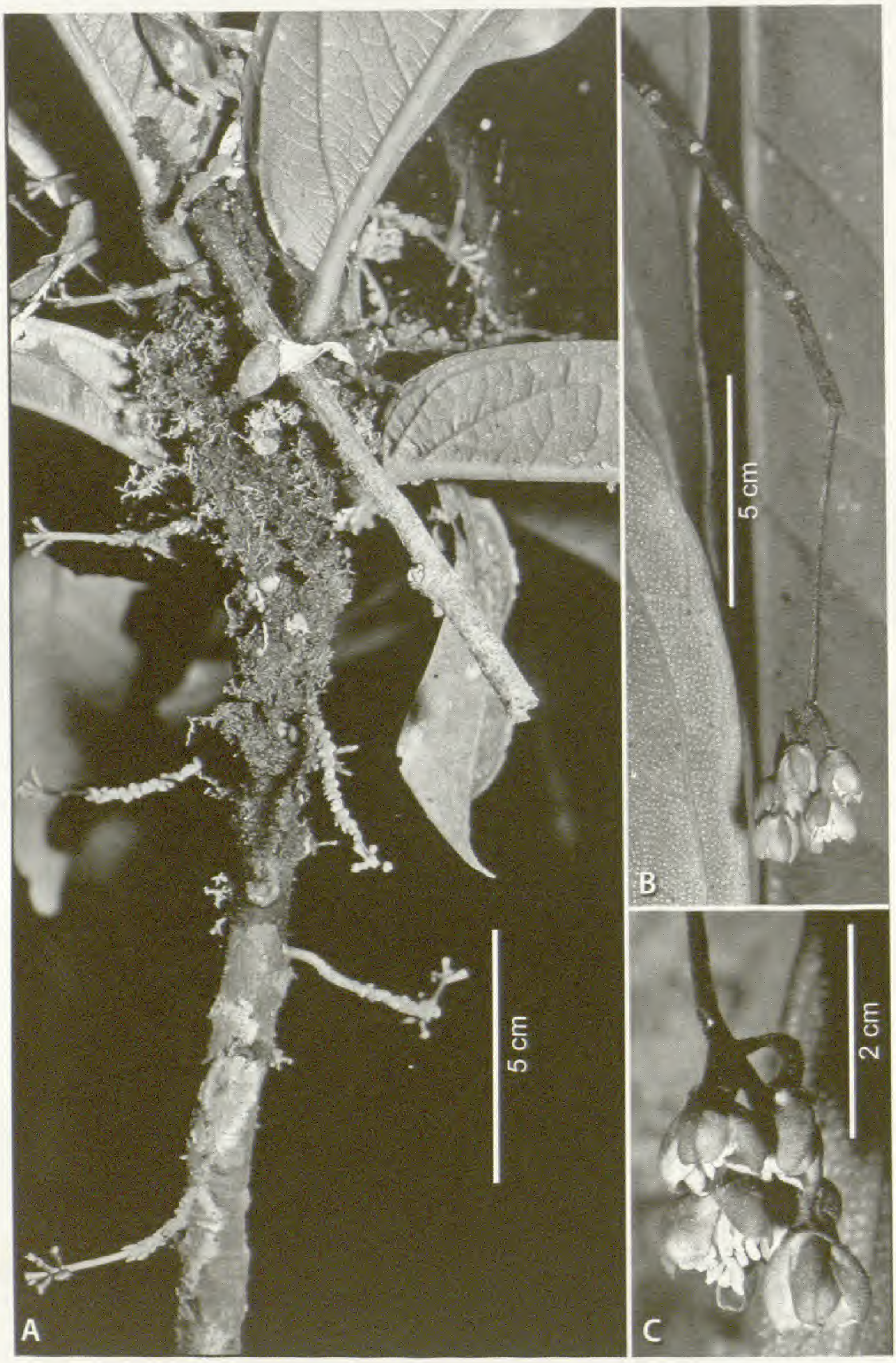


FIG. 2. *Quadrella dressleri*, a detritophilous, humilectic, Panamanian endemic. **A.** Dense, leafy crown of this single-stemmed treelet forms a "trash basket," wherein plant and animal detritus decomposes into humus soon invaded by adventitious, mycorrhizal roots from the stem. Panama: Colón, Santa Rita lumber road near Agua Clara. **B.** A 4- to 6-flowered, sub-umbellate-corymbose raceme, of which all flowers open at once. **C.** Close-up of the flowers nearly to anthesis. Panama: Panama, 12 km north of El Llano on Carti lumber road. Photos courtesy of Robert Dressler.

small white spots and lepidote abaxially, the apex abruptly acuminate to caudate-acuminate or gradually long-acuminate, the contracted tip (1–)2–7 cm, often ending in a hair-like extension of the midrib, the base narrowed to 4–8 cm, then rounded or truncate-retuse to subcordate or rarely cordate; lateral veins 9 to 15 (to 20), upward curved and strongly ascending. Inflorescences paniculiform, initially probably supra-axillary in, and projecting from, the leafy crown, but at maturity cauliflorous and projecting sideways to downward from the bare stem, structurally compounded of a slender, central, indeterminate, leafless racemiform

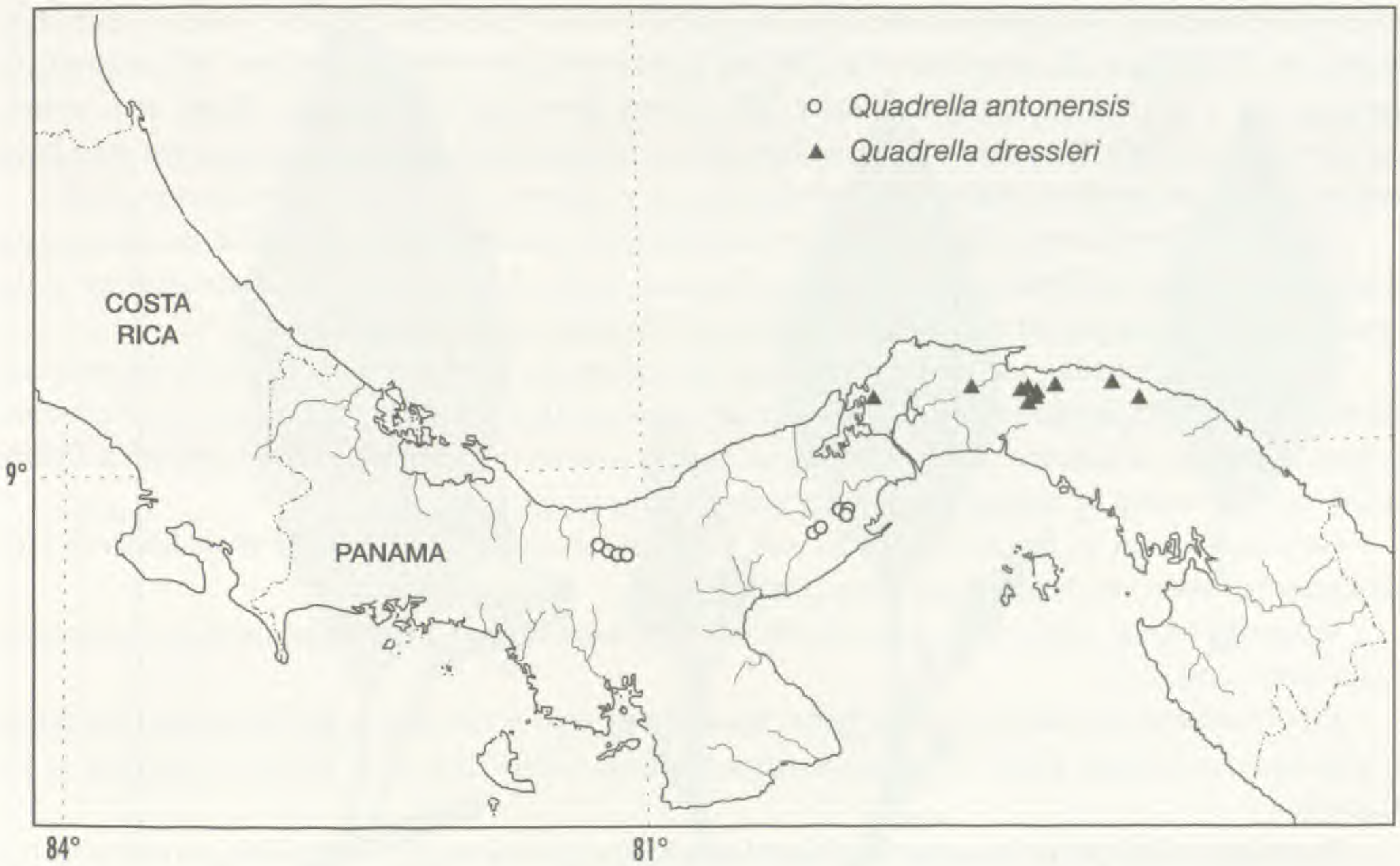


Fig. 3. Distribution map in Panama of *Quadrella dressleri* (solid triangles), mostly at low elevations north of the continental divide, and *Q. antonensis* (hollow circles), at mostly higher elevations near the top of the continental divide, showing their allopatric ranges separated by the Panama Canal.

branch, that is basally unbranched, bractless, sterile and terete for 1–20 cm, distally and laterally bears up to ca. 50 distichous, subulate, somewhat complanate and upward-curved persistent bracts, 3–4 mm long and mostly arranged 4–6(–15) mm apart, with each bract subtending a densely brown lepidote subumbellate raceme, 2–5(–8) cm, on pedicels (0.5–)0.7–1.3 cm, and 2 to 8 flowers near the tip, all of them opening at once; flower buds spherical, 4–6 mm diam. Up to 50 racemes are produced sequentially, alternately left and right, and, if not fertilized and developing into fruit, are soon deciduous. Sepals 1-seriate, triangular, 1 × 1.5 mm, ascending, light brown lepidote abaxially; petals ovate, 6–8 × ca. 3–5 mm, dirty white to cream or light-yellow, somewhat cucullate and strongly curved inward, divergent at anthesis (Stapf, pers. comm.), brown lepidote abaxially, glandular adaxially; stamens ca. 16 to 20, the filaments clavate, (4–)7–8 mm, glabrous to lightly stellate at base, the anthers ca. 1–1.2 mm, basifixed; gynophores absent, or at most only 1–3 mm, the ovaries ca. 1–3 mm, densely lepidote-stellate. Infructescences with pedicels 0.7–1.6 cm, the gynophores suppressed, the fruit pendulous, linear, 10–35 × 0.8–1.1 cm, strongly constricted between the (4 to) 12 to 17 seeds, tapering at both ends, densely brown or brownish green lepidote without, bright-orange within, at maturity dehiscent, splitting lengthwise along one suture, the seeds dangling from slender funicles, oblong, purplish or black, ca. 13–14 × 5 mm, immersed in an orange endocarp and surrounded by a bright orange aril; embryo green.

In its detritophilous habit, with the leaves densely arranged in pseudoverticils at the end of the branches collecting humus, the main stem with adventicious roots, and the flowers without androgynophores, *Quadrella dressleri* resembles *Q. antonensis*, the more common and similarly detritophilous allopatric species in Panama. However, *Quadrella dressleri* differs from the latter by the larger leaf blades, (25–)30–70 × 8–20 cm (vs. [12–]15–35[–40] × 3–10[–11] cm), and by its paniculiform inflorescences, bearing to 2nd order bracteate determinate, soon deciduous few-flowered racemes (vs. inflorescences racemose, multi-flowered, elongated, indeterminate), the persistent bracts of the inflorescences (Fig. 2A, vs. bracts soon deciduous); and the longer filaments, 7–8 mm (vs. 4–5 mm). In addition, a very different floral behavior has also been observed between the two species in the field. In *Quadrella dressleri*, the relatively few flowers of each short raceme are blooming at the same time (Fig. 2 B), but *Q. antonensis* has acropetal racemes, each sequentially opening only 1 to 3 flowers at a time of some 100 or more flowers per inflorescence (Stapf, pers. comm.; see also Sánchez 2001). On account of the stellate pubescence, and the long fruits bearing seeds with green embryos, this new species is placed in *Quadrella* subg. *Breyniastrum* (DC.) Iltis (Iltis & Cornejo 2010b).

Habitat and Distribution.—*Quadrella dressleri* is restricted to wet or very wet, tropical rain or submontane cloud forests of the Caribbean slopes of eastern Panama, north of the continental divide and east of the Panama Canal, in the provinces of Colon, San Blas and Panama, at 50–500(–850) m.

Phenology.—Flowering and fruiting apparently throughout the year, but on the basis of collections here examined, *Quadrella dressleri* seems to flower mostly between March and November, and is in fruit more so from September to January (April). The diurnal flowers have a very slight fragrance; between ca. 9:00 to 10:00, they are visited by beetles of Chrysomelidae Latreille (Stapf, pers. comm.).

Germination.—In its natural habitat as well as in laboratory testing, the seeds of *Quadrella dressleri* germinate between 3 to 4 days (Stapf, pers. comm.).

Vernacular names.—PANAMA. Basurera (Spanish, for trash basket), a name also used for *Q. antonensis* (Stapf, pers. comm.).

IUCN.—Due to the detritophyllous habit, *Quadrella dressleri* is not able to live in optimal conditions or even survive in open places after deforestation (Sánchez 2001). This new species is assigned to EN B1ab(iii).

Etymology.—The species is named for Robert Dressler, the great neotropical Orchidologist and expert on Panamanian Flora, who first noticed the distinctive characters of this remarkable species (Dressler 1985).

PARATYPES: **PANAMA. Colon:** Santa Rita lumber road, near Agua Clara rain gauge, 13 Apr 1980, *R. Dressler s.n.* (WIS [3]); Santa Rita Ridge Trail, *S. Mori & M. Crosby 6337* (MO). **Comarca de San Blas:** Cerro Brewster, *G. de Nevers, A. Henderson, H. Herrera, G. McPherson & L. Brako 6267* (MO); between Río Nergala Río Cangandí, *G. de Nevers & H. Herrera 4564* (MO); Cangandí, hills NW of village toward Río Nergala, *G. de Nevers, H. Herrera & S. Charnley 6528* (MO); quebrada affluente de Río Diable, Cordillera frente a Isla Narganá, *C. Galdames, E. Montenegro, C. Chung, H. Herrera 1558* (PMA, SCZ); Cerro Habú, *K. Sytsma, T. Antonio, R. Dressler 2658* (MO); trail to Cerro Obu [Habú], *G. de Nevers, H. Herrera & E. Gernado 7970* (MO). **Panama:** El Llano-Cartí rd., 10 km from Inter-Amer. hwy, *S. Mori & J. Kallunki 2318* (MO, PMA, WIS); El Llano-Cartí rd., 10–12 km from jct. w. Inter-Amer. hwy, *S. Mori & J. Kallunki 2855* (WIS); ca. 12 km N of El Llano, El Llano-Cartí rd., *R. Dressler 5920* (WIS [2]); ca. 13 km N from Pan-Amer. hwy, *B. Hansen & S. Mori 2996* (WIS [2, wood at USDA, MAD]); Kuna Yala, Nusagandi, sede de campo de PEMASKY, *R. Paredes, R. Foster, R. Pérez, S. Aguilar, Z. Batista, R. Mihalik, A. Salywon 899* (F, PMA, SCZ); Gorgas Memorial Labs, Camp. Quatro, 5–10 km NE of Altos de Pacora, *S. Mori & J. Kallunki 3409* (MO, US).

3a. Quadrella incana (Kunth) Iltis & Cornejo subsp. **incana,** Novon 17:452. 2007. (**Figs. 4 A–D, 5 A, B, E, F, J–L, 9 lower map**). BASIONYM: *Capparis incana* Kunth, Nov. Gen. & Sp. Pl. 5:94. 1821. *Octanema incana* (Kunth) Rafinesque, Sylva Tellur. 108. 1838. TYPE: MEXICO. GUERRERO: "Crescit in declivitate occidentali montium Mexicanorum, inter Mescala et Estola," 300 m, Apr, *A. Humboldt & A. Bonpland s.n.* (lectotype P, designated by Iltis & Cornejo (2007); ISOTYPE: B–W 10,045, B–W photo 9479 at WIS).

Capparis pauciflora C. Presl [nom. illeg., non *Capparis pauciflora* Kunth (1821)], Rel. Haenk. 2:86. 1835. TYPE: MEXICO. GUERRERO?: "In terris occidentalibus Mexici," *T. Haenke s.n.* (HOLOTYPE: PR; ISOTYPES: LE, MO).

Capparis karwinskiana Schlechtendal, Linnaea 10:237. 1836. TYPE: MEXICO: San Bartolo, 1830, *W.F. Karwinski s.n.* (HOLOTYPE: M; ISOTYPE: BR, BR photo at WIS).

For a complete description of this species see Iltis & Cornejo (2007: 452).

Habitat and Distribution.—In dry woodlands, from southwestern to eastern Mexico, where very common, rarely into southeastern Texas, east to Guatemala and rarely into Honduras (Iltis & Cornejo 2007: 453).

3b. Quadrella incana var. **triangularis** Cornejo & Iltis, var. nov. (**Figs. 5 C, D, 9 lower map**). TYPE: MEXICO. JALISCO: thorn scrub on inner beach of Bungalow Major Beach, ca. 8 km NW of Chamela, 19°33'N 105°08'W, 2 m, 22 Jun 1984, *H.H. Iltis & S. Wisniewski 29194* (HOLOTYPE: WIS [fl]; ISOTYPE: MEXU [st]).

A subspecies *incanae*, sepalis triangularis, 1–1.5 mm longis, 1–1.3 mm latis et filamentis minoribus ca. 4 mm longis (vs. 6–9 mm), differt.

Sepals triangular, flat, minute, 1–1.5 × 1–1.3 mm (Fig. 5 C–D), ascendent at anthesis, each subtending a

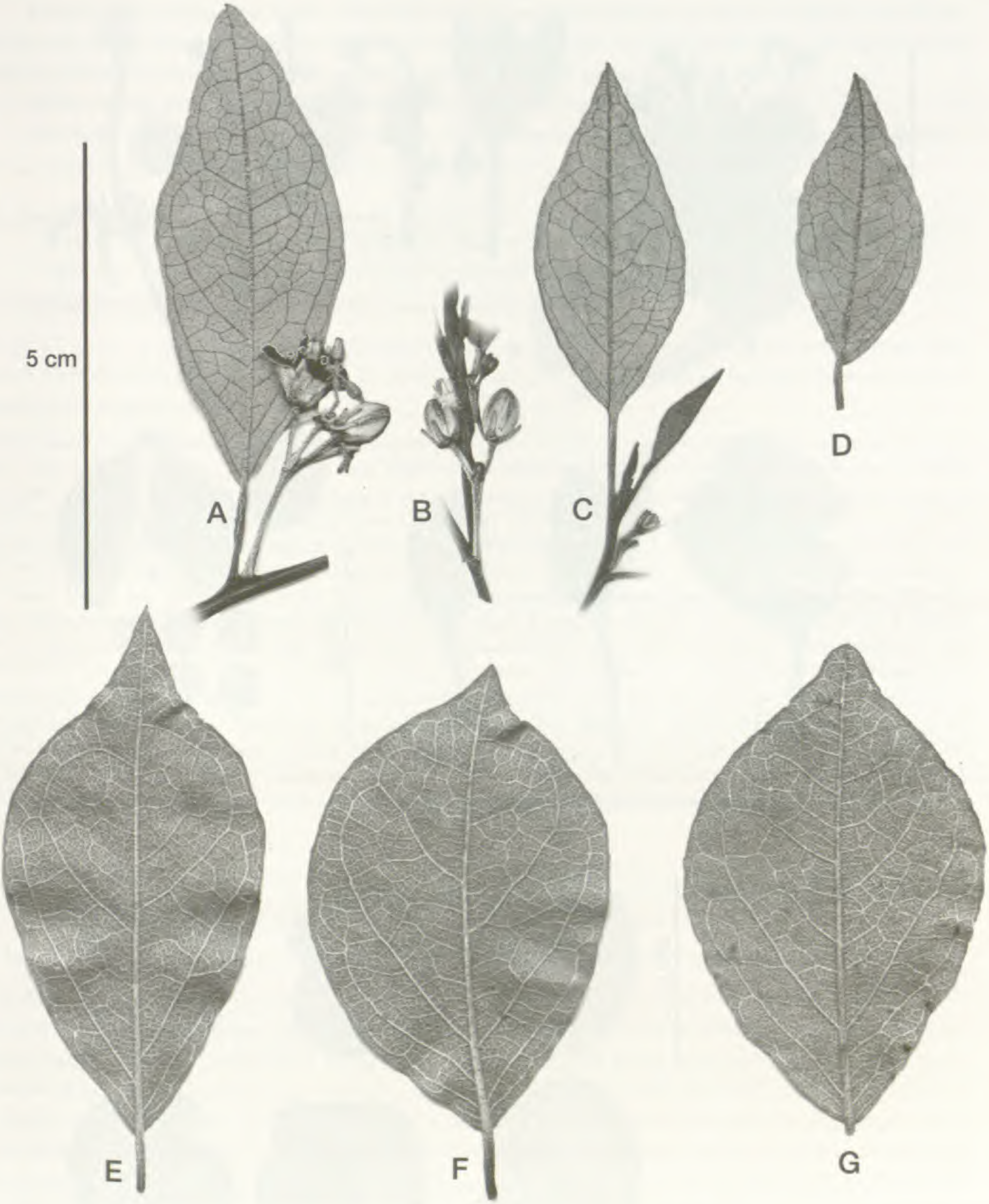


Fig. 4. Quadrella incana: A–D. Leaves and inflorescences of subsp. incana, with few, upward-arching, interconnecting veins, and flowers with linear sepals and short peduncles. E–G. Quadrella incana subsp. yucatanensis, the obovate-leaved subspecies, native mostly to the Yucatan Peninsula. A–D, from *Martínez 20248*, MEXU. E–G, from the LL-TEX isotype: *Lundell & Lundell 7452*.

1–1.5 mm gland, which persists in fruit; petals 4–7 × 3–4 mm, white but rusty ferrugineous and tomentose stellate abaxially, apparently glabrous adaxially; stamens with filaments ca. 4 mm, densely white stellate on basal half to entire length; gynophores 4–5.5 mm, the ovaries ellipsoid, 2 mm. Infructescences with gynophores 5–7 mm, the fruits 8–20 × 6–10 mm, reddish green without

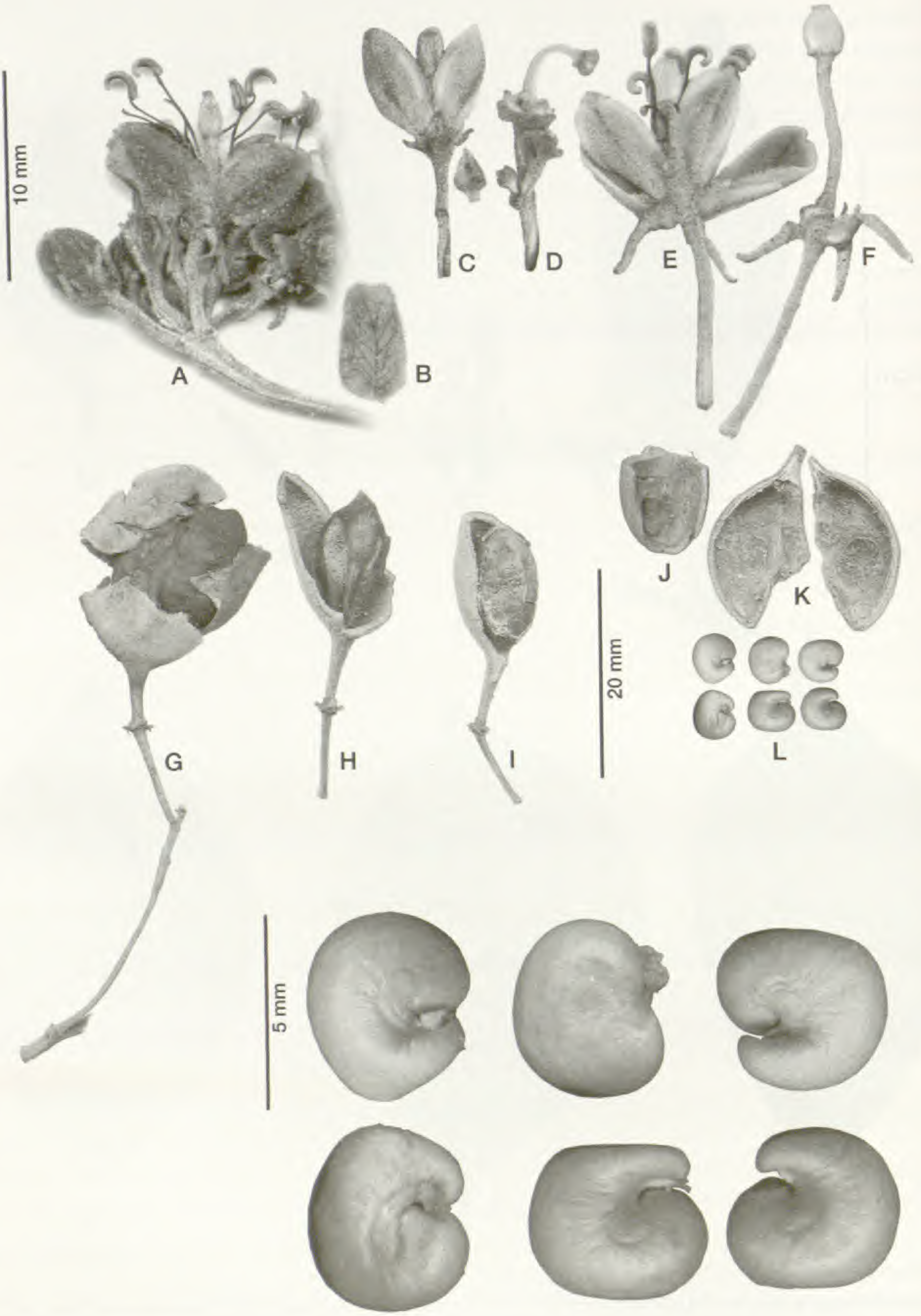


Fig. 5. A, B, E, F, J, K, L: *Quadrella incana* subsp. *incana*. **A.** Clustered, subcorymbose inflorescence, with linear sepals, one open flower with eight stamens. **B.** One petal of A, showing pinnate nervature. **E.** Dried linear, ± contorted, reflexed sepals. **F.** Flower at postanthesis. **J, K:** ± thick fruit coats. **L.** Three cochleate-reniform cleomoid seeds (each pictured from both sides after removal of soft red aril), with firm, hard brittle testa and a "cleomoid" cochleate-reniform white embryo within, the same six seeds enlarged below. **C–D.** *Quadrella incana* var. *triangularis*. **C.** Flower with broadly triangular sepals. **D.** Flower at postanthesis. **G–I.** *Quadrella morenoi*. **G.** Showing large, solitary, straight, green capparoid embryos, enclosed by a thin, fragile testa (I) enclosed by a ± thickened fruitcoat. A, B: *Moreno & Robleto 22899* (WIS). C, D: *Iltis & Wisniewski 29194* (from the holotype, WIS). E, F: *Johnson 4370* (WIS). G: *Espinosa 462* (WIS). H–I: *King 239* (WIS). J, L: *Quero 2983* (WIS). K: *Pringle 7291* (WIS).

Except for its variable leaf shape, *Quadrella incana* is a rather uniform species in its flowers and fruits. All but two (from westernmost Jalisco) of the 350 specimens studied for the species have the characteristic filiform (when dry) or linear, densely stellate sepals, and stamens with filaments 6–9 mm.

IUCN.—There is not sufficient information of this subspecies, DD.

Etymology.—The infraspecific epithet refers to the triangular sepals, which characterize this variety.

PARATYPE: **MEXICO. Jalisco:** Chamela, entrada a la Salinas, 22 Aug 1980, *L. Pérez 1931* (IBUG, MEXU).

3c. Quadrella incana subsp. **yucatanensis** (Lundell) Iltis, comb. et stat. nov. (**Fig. 4 E–G**). BASIONYM: *Capparis yucatanensis* Lundell, Bull. Torrey Bot. Club 69:389. 1942. TYPE: MEXICO [Yucatan]: Chichen Itzá, off Kaua road, 8 Jun 1938 (fr), *C. Lundell & A. Lundell 7452* (HOLOTYPE: MICH; ISOTYPES: DS, F [not seen], GH, LL-TEX [2], NY, US]).

A *Quadrella incana* subsp. *incana* affinis a qua differt lamina obovata vel rombica.

Quadrella incana subsp. *yucatanensis* is characterized by its broadly obovate to rhomboid leaves, most commonly represented in specimens from the Yucatan Peninsula, but scattered beyond, here and there, throughout much of the range of *Q. incana*.

Selected specimens: **MEXICO. Campeche:** Mun. Campeche, ciudad de Campeche, *C. Gutiérrez 6824* (MEXU); región de Calakmul, Mun. Holpechén, *E. Martínez, D. Alvarez & S. Ramírez 30888* (MEXU). **Quintana Roo:** Puerto Morelos, Playa Ojo de Agua, *P. Moreno 616* (MO). W of Puerto Morelos, *G. Davidse, M. Sousa, A. Chater & E. Cabrera 20043* (MEXU). Isla Mujeres, Playa Lancheros, *E. Cabrera & H. de Cabrera 13090, 15425* (MEXU). Isla de Cozumel, *E. Cabrera, O. Téllez & H. de Cabrera 11147* (MEXU, MO); 35 km S de San Miguel de Cozumel, *E. Cabrera & H. de Cabrera 8710* (MEXU, NY). **Yucatan:** Mun. Progreso, 1 km W de Chuburna Puerto, *M. Pérez 466* (MEXU), *F. Kú & Yam 455* (MEXU); Progreso, *Román s.n.* (F); E of Progreso, *A. Bradburn 1085* (WIS); ca. 1 mi W of Chicxulub Puerto, *G. Webster, S. Lynch & G. Breckon 17566* (DAV); 10 km E de Chicxulub Puerto, *E. Cabrera & H. de Cabrera 8809* (K, MEXU, MO, NY); Mun. Telchac Puerto, *F. Kú & Yam 245* (MEXU); 5 km E de Telchac Puerto, *E. Reyes 323* (MEXU); 10 km E de Telchac Puerto, *E. Cabrera & H. de Cabrera 10742* (MEXU); 15 km O de Telchac Puerto, *E. Cabrera & H. de Cabrera 11313* (TEX, MEXU); Dzilam de Bravo, *J. Tun 210* (MEXU); 4–6 km O de Las Coloradas, *E. Cabrera & H. de Cabrera 15741* (MEXU); sine loc., *E. Alexander s.n.* (NY). **Chiapas:** Mun. Ocozocoautla, Reserva del Ocote, *J. Calzada, P. & B. Gómez 10062* (MEXU). Mun. Chicoasén, 500 m al S de Chicoasén, *A. Reyes-García 544* (BM, MEXU). **Oaxaca:** Distr. Tehuantepec, El Salado, *R. Cedillo & R. Torres 1081* (CAS, MEXU); subida al cerro Guiengola por el camino que va a Las Palmitas, *M. Torres et al. 896* (MEXU, MO); 1 km N de las ruinas del cerro Guiengola, *M. Torres et al. 812* (MEXU, MO). **Jalisco:** Chamela, Las Salinas, *C. León 84* (MEXU); Mun. La Huerta, entrada a las Alamandas, *E. Lott 1717* (CAS, MO). **Colima:** 1 km NW de Tamala (Aquiles Serdán), *R. Cuevas & L. Guzmán 4927* (WIS [2], ZEA). **HONDURAS. Comayagua:** 16.6 mi S of Siguatepeque, *J. Walker 423* (DUKE, F, GH, US).

4. Quadrella lindeniana Cornejo & Iltis, sp. nov. (**Figs. 6, 7**). TYPE: MEXICO. QUINTANA ROO: Isla de Cozumel, a 1 km NO del Faro de la Punta Celarain, 4 Jun 1986 (fl), *E. Cabrera & H. de Cabrera 11433* (HOLOTYPE: MEXU [MEXU photocopies at AAU, B, BM, COL, DAV, F, GH, GUAY, K, MA, NY, P, QCA, QCNE, S, U, UC, US, WIS]; ISOTYPES: MO, TEX).

Species affinis *Quadrella indicae* (L.) Iltis & Cornejo, a qua differt inflorescentia pauciflora, cum floris minoribus et fructus angustibus.

Shrub to small trees, to 8 m tall, rusty or brown lepidote-peltate throughout. Leaves spirally arranged; petioles 2–8 mm, canaliculate; blades conduplicate and densely stellate when young, at maturity oblanceolate to narrowly elliptic, 3–9 (–11) × 0.8–2.5 cm, dull to shiny and glabrescent adaxially, densely peltate-lepidote abaxially, the base cuneate, the apex acute to acuminate, usually apiculate, sometimes obtuse or rounded, rarely emarginate; lateral veins (6 to) 7 to 12 pairs. Inflorescences umbellate or corymbose, 1 to 4 from axils of uppermost branch leaves, the peduncle ± flattened, 1.5–5 cm, bearing (1 to) 4 to 10 clustered flowers at the tip; floral bracts linear to narrowly triangular, ca. 2.5 mm, soon deciduous; pedicels 0.6–1.5 cm, flattened; flowers white or cream with sweet odor. Sepals 1-seriate, narrowly triangular to triangular, 1.5–2.4 × 1–2 mm, usually ascending, at anthesis barely covering the base of the petals, densely lepidote abaxially, appressed pilose adaxially, each subtending a triangular, acute, erect, scale-like flattened (when dry) gland, the gland 1–2 mm, lepidote to lepidote-stellate abaxially, glabrous adaxially; petals suborbicular to obovate, 5–7 × 4–5 mm, densely stellate tomentose, except for a thin longitudinal row of lepidote-stellate trichomes on midrib abaxially; stamens ca. 15 to 30, the filaments 7–10 mm, lepidote to stellate at the base, the anthers 1.5–2 mm; androgynophores ca. 1 mm; gynophores 2–7 mm, the ovaries 2–3 × ca. 1 mm, both densely golden lepidote, the stigmas capitate to truncate, sessile, drying dark brown. Infructescences with

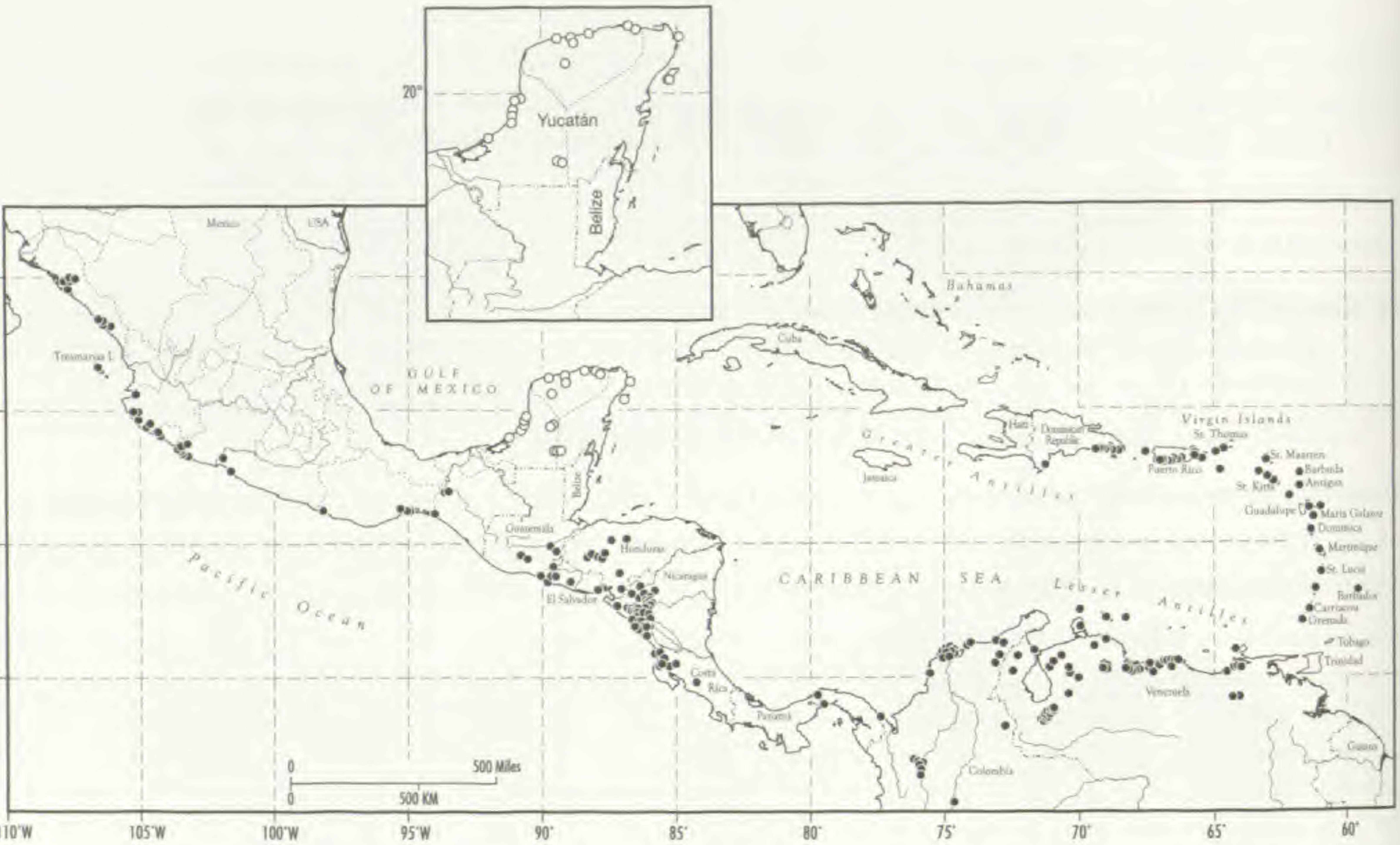

20°
Yucatán
Belize
Mexico
USA
Tresmarias I.
GULF OF MEXICO
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Panama
Pacific Ocean
Bahamas
Cuba
Haiti
Dominican Republic
Jamaica
Greater Antilles
Puerto Rico
Virgin Islands
St. Thomas
St. Maarten
Barbuda
Antigua
St. Kitts
Guadalupe
Maria Galante
Dominica
Martinique
St. Lucia
Barbados
Carriacou
Grenada
Tobago
Trinidad
CARIBBEAN SEA
Lesser Antilles
Venezuela
Colombia
Guiana
0 500 Miles
0 500 KM
25°
20°
15°
10°
110°W
105°W
100°W
95°W
90°
85°
80°
75°
70°
65°
60°

Fig. 6. Distribution map of *Q. lindeniana* (hollow circles) and *Quadrella indica* (solid circles), showing their allopatric ranges.

peduncles 1.5–5 cm, the pedicels 1–2.5 cm, the gynophores 3–9 mm, lepidote to glabrate, the fruits slender, ± torulose, 1.5–12 × 0.4–0.7 cm, cream, yellow or orange to brown, densely lepidote without, at maturity splitting lengthwise along one suture, exserting the orange-arillate seeds on the bright orange pulpy endocarp of their valves; seeds cochleate-reniform, 5–8 × 4–5 mm.

Quadrella lindeniana is vegetatively very similar to the allopatric *Q. indica*, but differs by having distinctively smaller flowers (Fig. 7 B, C), with petals only 5–7 × 4–5 mm (vs. 8–14 × 6–8 mm), filaments only 7–10 mm (vs. [15–]18–30 mm), gynophores only 2–7 mm (vs. [12–]17–40 mm) in flower, and 3–9 mm (vs. 12–45 mm) in fruit, ovaries 2–3 mm (vs. 3–5 mm) and fruits narrower, 4–7 mm (vs. [6–]7–12[–14] mm). In addition, the inflorescences of *Quadrella lindeniana* are truly corymbose or even umbellate, having fewer flowers ([1]4 to 10) than those of *Q. indica*, which has the inflorescences distinctively more racemose-umbellate to racemose-corymbose, bearing more flowers (8–14[–20]).

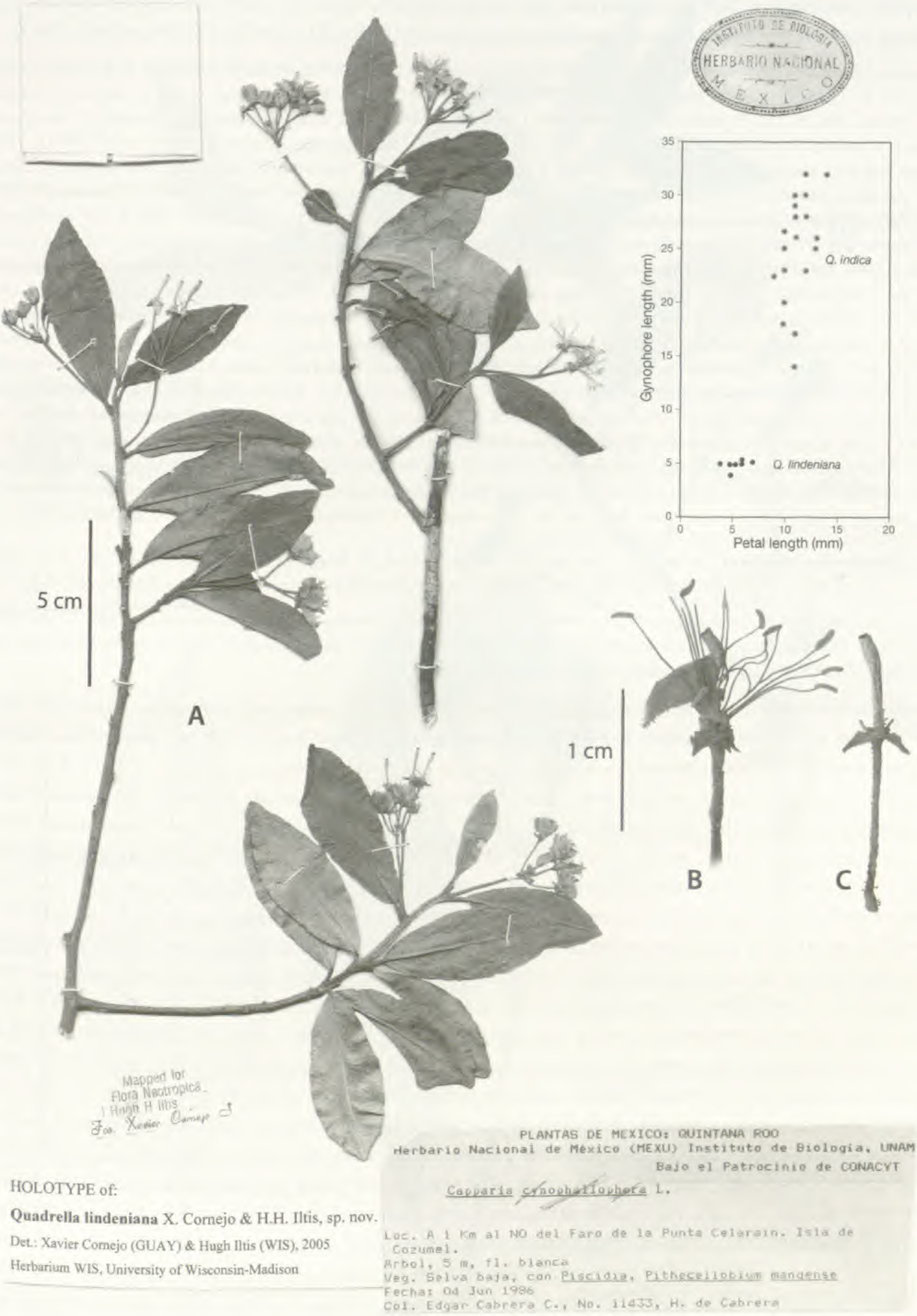
Habitat and Distribution.—*Quadrella lindeniana* is restricted to Mexico's Yucatan Peninsula, where it occurs from the landward mangrove fringes in the far north, through dry thorn scrub to subdeciduous lowlands and subevergreen forests in the south, often growing on coastal dunes or rocky soils, and persisting in disturbed forests. It is allopatric to the similar but widespread *Q. indica*, which ranges from the Mexican states of Sinaloa and Nayarit to Costa Rica, mostly in the dry Pacific coastal areas, and from the central West Indies to Colombia and Venezuela (Fig. 6).

Phenology.—Flowering from April to June, and fruiting from July into September.

Vernacular names.—MEXICO. Negrita (*J.D. Shepherd 180*), salvo (*Zamora 4795*).

IUCN.—Although *Quadrella lindeniana* is restricted to the Yucatan Peninsula, the many fertile collections suggest however, that there are still a reasonable number of healthy populations of this new species, thus *Q. lindeniana* deserves a lower priority, LC.

Etymology.—The earliest collections of *Quadrella lindeniana* were apparently made by a young Jean Jules Linden (1817–1898) from the "environs de Campeche," when, in May of 1838, he collected the species in full bloom with the comment (from the French), that the flowers were white and fragrant. Labelled by hand simply as "*Capparis indica Linden 999*" in the Kew and Florence Webb herbaria (now included at FI), but as


INSTITUTO DE BIOLOGIA
HERBARIO NACIONAL
MEXICO
35
30
25
20
15
10
5
0
Gynophore length (mm)
0
5
10
15
20
Petal length (mm)
Q. indica
Q. lindeniana
5 cm
A
1 cm
B
C

Mapped for
Flora Neotropica
Hugh H Iltis
Fco. Xavier Cornejo

HOLOTYPE of:

Quadrella lindeniana X. Cornejo & H.H. Iltis, sp. nov.

Det.: Xavier Cornejo (GUAY) & Hugh Iltis (WIS), 2005

Herbarium WIS, University of Wisconsin-Madison

PLANTAS DE MEXICO: QUINTANA ROO
Herbario Nacional de México (MEXU) Instituto de Biologia, UNAM
Bajo el Patrocinio de CONACYT

Capparis ~~cynophallophora~~ L.

Loc. A 1 Km al NO del Faro de la Punta Celarain. Isla de Cozumel.
Arbol, 5 m, fl. blanca
Veg. Selva baja, con Piscidia, Pithecellobium mangense
Fecha: 04 Jun 1986
Col. Edgar Cabrera C., No. 11433, H. de Cabrera

Fig. 7. ***Quadrella lindeniana*. A. Flowering branches. B. Small flower in anthesis, with three petals removed. C. Flower in post-anthesis. (A–C. *Cabrera & de Cabrera 11433*, MEXU holotype). Upper right: Scatter diagram of gynophore length vs. petal length, distinguishing *Q. lindeniana* from *Q. indica*.**

Capparis lindeniana in the Paris herbarium, this nomen nudum, which we have here happily adopted, was written down in the same unknown handwriting as that on the locality label itself (Urban 1902–1903).

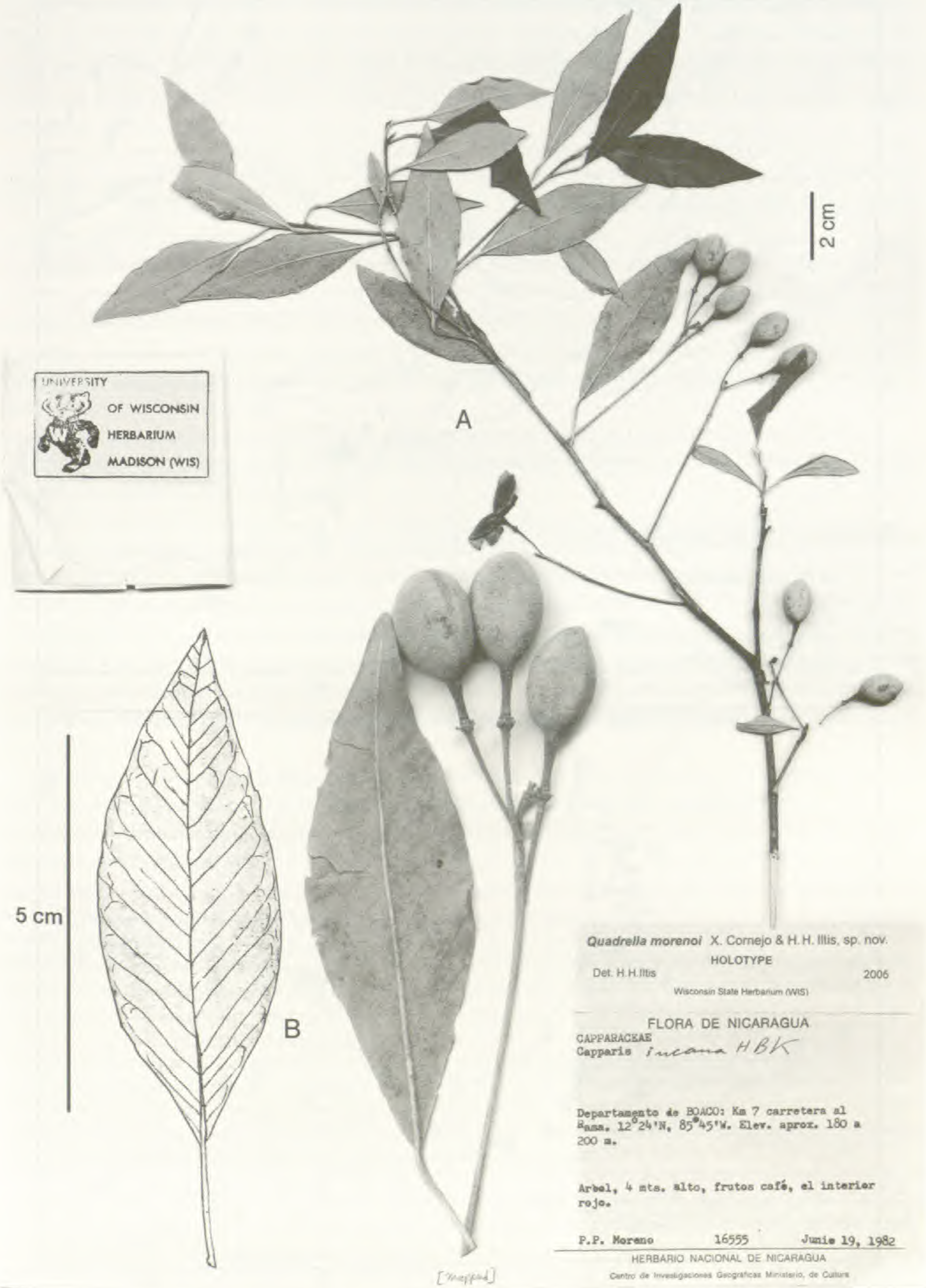
Paratypes: **MEXICO. Campeche:** Mun. Campeche, Campeche, *C. Gutiérrez 6825* (MEXU); Lerma bei Campeche, *C. & E. Seler 4018* (A, B, F, GH, K, U); environs de Campeche, May 1836 (fl), *M. [sic!] Linden 999* (FI, K, P). Mun. Calakmul, *E. Lira, E. Madrid & E. Gamboa 870* (MEXU, TEX), *E. Lira, E. Madrid & E. Gamboa 1190, 1203* (MEXU); 36 km S de la caseta de entrada a Calakmul, *E. Martínez, D. Alvarez, S. Ramírez & G. Bacab 28302* (BM, MEXU, MO [not seen]); km 100 carr. Escárcega-Chetumal, *E. Lira et al. 1271* (MEXU, TEX). Camp. Inst. Nac. Antropología e Historia de Calakmul, *E. Martínez, D. Alvarez & S. Ramírez 27627* (BM, MEXU, MO [not seen]); 2 km O de Calakmul, *E. Martínez, D. Alvarez, S. Ramírez 27640, 27681* (MEXU). Mun. de Champotón, camino a Calakmul, *P. Zamora 4795* (TEX, UACAM); alrededores de la zona arqueológica de Calakmul, *P. Alvaro 334* (MEXU); 3 km N de Champotón, sobre la carr. a Campeche, *E. Cabrera et al. 2748* (MEXU). 6 km NE de Champotón, *E. Cabrera, H. de Cabrera & O. Canul 8494* (MEXU, MO), *E. Cabrera & H. de Cabrera 14446* (MEXU); 8 km N de Champotón, *E. Cabrera & H. de Cabrera 11802* (MEXU, MO); 9 km N de Champotón, *E. Cabrera & H. de Cabrera 14062* (MEXU, MO); 15 km al N de Champotón, *E. Cabrera & H. de Cabrera 13388* (MEXU); 2 km S de Si-ho Playa, *C. Chan 5118, 5385* (MEXU); Chincaná, *C. Gutiérrez 4437* (TEX, UACAM); near Xpujil, *J.D. Shepherd 180* (WIS); Zona Arqueol. Becan, 2 km O de Xpujil, *E. Cabrera & H. de Cabrera 6954* (MEXU, MO, NY); alrededores Zona Arqueol. Becan, *E. Cabrera, H. de Cabrera & O. Canul 8403* (MEXU, MO); 33 km al SO de la desviación a Sabancuy, sobre la carr. Campeche-ciudad del Carmen, *E. Cabrera & H. de Cabrera 11909* (CAS, MEXU, MO, WIS). **Yucatan:** Rubble mounds near Uitzina, *S. Darwin, D. White & C. Trenary 2708* (WIS); Hda. Subin-Okal al SE de Hda. Ermita, *O. Enríquez 696* (MEXU, US); Progreso, May 1933, *R.S. Flores s.n.* (F); Lake Chichankanab, *G. F. Gaumer & sons 23679* (C, F, GH, K, MA, MO, NY, US); 13 km W of El Cuyo, *H. Quero & R. Grether 2455* (BM, MEXU, MO); 6 km S de Telchak Puerto, *E. Cabrera & H. de Cabrera 11683* (MEXU); Tizimín, antes de llegar al Cuyo, *C. Chan 5161* (MEXU); Mun. Dzemul, 6 km N de Dzemul, *S. Escalante 1026* (MEXU); Mun. Dzilam, *I. Espejel 639* (MEXU). **Quintana Roo:** Isla de Cozumel, 1 km N del Faro de la Punta Sur, *E. Cabrera & H. de Cabrera 8725* (MO, NY); Isla de mujeres, 500 m al N de Playa Lancheros, *E. Cabrera & H. de Cabrera 14193* (CAS, MEXU, MO).

5a. Quadrella morenoi Cornejo & Iltis, sp. nov. (**Figs. 5 G–I, 8, 9 upper map**). Type: NICARAGUA. Boaco: km 7 carr. al Rama, 12°24'N 85°45'W, 180–200 m, 19 Jun 1982 (fr), *P. Moreno 16555* (holotype: WIS; isotypes: HNMN, MO, VDB).

Species *Quadrella incanae* (Kunth) Iltis & Cornejo affinis, a qua differt semina plerumque solitaria, ovoidea ad elipsoidea vel obovoidea, longioribus, 8–15 mm longus (vs. 4.5–6 mm), testa membranacea et delicatula, embryo grandior, ortho et viridis; foliis cum venis lateralibus, 7 ad 16; pedunculis longioribus, (1–)2–8 cm longus.

Small shrubs to trees, to 8 m tall and 10 cm or more dbh, stellate pubescent throughout, with light grayish to rusty or whitish trichomes. Leaves spirally arranged; petioles 0.5–2.3(–3.5) cm; blades often hastate when young, at maturity narrowly to broadly elliptic or lanceolate to obovate or ovate, (2.5–)3–8.5(–10) × 1–4(–5) cm, grayish green and glabrate adaxially, whitish to grayish stellate abaxially, the base attenuate or cuneate to obtuse, the apex usually acute to long-acuminate, occasionally obtuse, rounded and retuse or apiculate; lateral veins 7 to 16 pairs (Fig. 8), these usually parallel from the base, arching upward only near the margin. Inflorescences axillary, one to several per branchlet, the peduncles slender, (1–)2–8 cm, whitish stellate, ending in a short, crowded, subumbellate to corymbiform raceme of 3 to 8 (to 12) flowers; floral bracts linear to linear-lanceolate, 2–2.5(–5) mm, densely stellate abaxially, soon caducous; pedicels (0.3–)0.7–1.9 cm. Sepals 1-seriate, linear to filiform, 2.5–5 mm, densely stellate, each subtending a triangular gland, 1 mm, densely canescent abaxially; petals minute, broadly elliptic to oblong, 4.5–6 × 2.2–3 mm, white to brown tomentose stellate and costate abaxially, sparsely stellate to glabrous, with pinnate nervature adaxially; stamens 8, the filaments 6–7 mm, stellate on basal half to sometimes almost entire length, the anthers 1.5–2.8 mm, yellow; androgynophores ca. 1 mm, glabrous; gynophores 3–6 mm, the ovaries ca. 2 mm long, ellipsoid, longitudinally faintly ribbed at anthesis, both densely whitish stellate. Infructescences with pedicels 0.3–1.8 cm, the gynophores 0.3–0.8 cm, the fruits broadly ellipsoid to obovoid, 13–25 × 8–11 mm, usually brown to reddish brown or red [often also yellow in Costa Rica], densely stellate tomentose without, red within, at maturity dehiscent, splitting open into 2 to 4, ± thin, recurved valves to expose the seed; seeds often solitary (sometimes two), narrowly ovoid to ellipsoid or obovoid, 8–15 × 6–9 mm, surrounded by an orange to red aril that separates with the seed cleanly from the valves, the testa thin and delicate, papery membranous, not invaginated into the dark green embryo, the embryo straight, oblongoid and somewhat flattened, has the thick cotyledons barely folded one into, and over, the other and around the pointed radicle.

Quadrella morenoi is remarkably distinct from the surprisingly but only superficially similar *Q. incana* (of *Quadrella* subg. *Intutis*) by its often solitary (sometimes 2), 2- to 3- times larger seed (Fig. 5 G–I), covered by



Quadrella morenoi X. Cornejo & H. H. Iltis, sp. nov.
HOLOTYPE
Det. H. H. Iltis 2006
Wisconsin State Herbarium (WIS)

FLORA DE NICARAGUA
CAPPARACEAE
Capparis incana HBK

Departamento de BOACO: Km 7 carretera al Rama. 12°24'N, 85°45'W. Elev. aprox. 180 a 200 m.

Arbol, 4 mts. alto, frutos café, el interior rojo.

P.P. Moreno 16555 Junio 19, 1982
HERBARIO NACIONAL DE NICARAGUA
Centro de Investigaciones Geográficas Ministerio, de Cultura

FIG. 8. *Quadrella morenoi*: **A.** Fruiting branch. **B.** Close up of the uppermost infructescence of A, showing the distinctive, elongate peduncle bearing the ovoid, often single-seeded fruits. Note attached leaf and a re-drawing of its dense nervature at left (drawn from the WIS holotype, *Moreno 16555*).

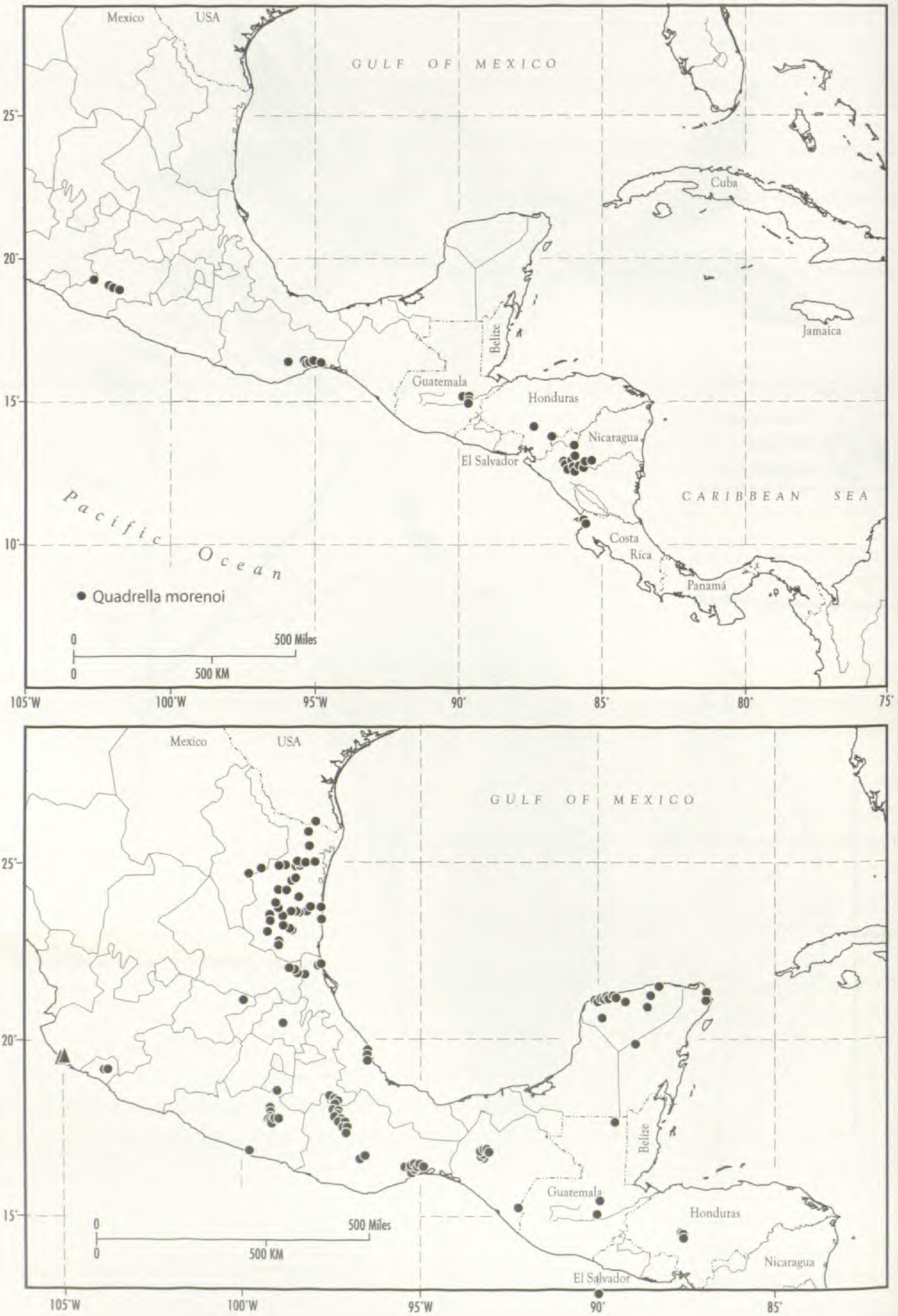

Mexico
USA
GULF OF MEXICO
Cuba
Jamaica
Belize
Guatemala
Honduras
Nicaragua
El Salvador
CARIBBEAN SEA
Costa Rica
Panamá
Pacific Ocean
● Quadrella morenoi
0 500 Miles
0 500 KM
25°
20°
15°
10°
105°W
100°W
95°W
90°
85°
80°
75°
Mexico
USA
GULF OF MEXICO
Belize
Guatemala
Honduras
Nicaragua
El Salvador
0 500 Miles
0 500 KM
25°
20°
15°
105°W
100°W
95°W
90°
85°

Fig. 9. Upper map: Distribution of *Quadrella morenoi* (solid circles). Lower map: Distribution of *Quadrella incana*: *Q. incana* subsp. *incana* (solid circles), ranging from southern Texas to Honduras; and, *Q. incana* var. *triangularis* (solid triangles) restricted to southern Jalisco, Mexico.

a unique, translucent, thin, papery or membranous testa; by inflorescences borne on much longer peduncles (Fig. 8, vs. 0.4–2.5(–3) cm in *Q. incana*); and by the greater number (7 to 16 vs. 3 to 8) and denser pattern of the lateral veins. This new species is placed in *Quadrella* subgen. *Breyniastrum* (Iltis & Cornejo 2010 b), on account of the stellate pubescence covering the plant throughout and its seeds with green embryos with thin testas.

Quadrella morenoi existed unrecognized for 189 years (since 1821) as part and parcel of the superficially similar *Q. incana*, so in *Flora of Guatemala* (Standley & Steyermark 1946), and the *Flora Arborescente de Costa Rica* (Zamora 1989), but also in the *Flora de Nicaragua* (Iltis 2001), where nevertheless the often solitary seeds and green color of the embryos were first mentioned but not discussed.

Habitat & Distribution.—*Quadrella morenoi* occurs scattered from southern Mexico (Michoacan) to southwestern Costa Rica (Fig. 9, upper map), but is especially common in Central Nicaragua. Only at Tehuantepec in southern Oaxaca, Mexico, this new species overlaps parapatrically the range of the more common *Q. incana*. *Quadrella morenoi* ranges from sea level to 930 m in deciduous thorn scrub, gallery forests and semi-deciduous tropical dry forests and woodlands. It persists in secondary vegetation and grazed areas, often on rocky and volcanic soils.

Vernacular names.—MEXICO (Oaxaca): Arnica (*Salas et al. 1310*); mata gallina (*Cervantes 2168*).

Phenology.—Flowering mostly from February to July (rarely in November), and fruiting mostly from May into September (rarely in February).

Seed morphology.—Unlike the one to six seeds of *Quadrella incana* fruits and those of the related *Q. ferruginea* (L.) Rafinesque complex of the Greater Antilles (Rankin & Greuter 2004), which have their white embryo enclosed by a smooth, relatively thick, hard testa typically cleomoid in shape (i.e., with the seed cleft deeply invaginated between the claws of the cochleate-reniform seed; Fig. 5 J–L), the one to two seeds of *Q. morenoi* (Fig. 5 G–I) have an essentially straight and non-cleomoid green embryo covered by a unique, paper-thin, testa that is not invaginated into the seed and, when fresh or in herbarium material, is easily removed. While the embryos of *Quadrella incana* are whitish or cream, with their very thin cotyledons doubly conduplicate, the deep-green cotyledons of *Q. morenoi* are thicker, somewhat irregularly but simply folded one into the other.

Etymology.—The species is named in honor of Pedro Paul Moreno, the energetic Nicaraguan botanist at HNMN, an avid explorer of the Nicaraguan flora and collector of the type specimens.

IUCN.—The numerous and relatively recent collections of *Quadrella morenoi* indicate that this species deserves a lower concern, LC.

PARATYPES: **MEXICO. Michoacan:** ca. Buenavista Tomatlán, *J. Rzedowski 22290* (DS, ENCB, MICH, TEX, WIS); Cortina de la Presa Zicuirán, ca. La Huacana, *J. Rzedowski 37368* (ENCB, MEXU, MO). 3 km N de la Presa Zicuirán, carr. Apatzingán-La Huacana, *R. Torres & E. Martínez 382* (CAS, MO); Mun. Múgica, along Morelia-Lázaro Cárdenas autopista, *V. Steinmann 3130* (MEXU) ; along MEX 37, ca. 14 km N of Cuatro Caminos, *V. & P. Steinmann 1644* (MEXU). **Oaxaca:** San Jerónimo, *C. Mell 2204* (NY) ; 3 km E de San Juan Guigoyache, carr. Oaxaca-Tehuantepec, *J. Magallanes 202* (MEXU, WIS); 70 mi SE de Oaxaca, *G. Webster 11642* (DAV, MEXU); Distr. Tehuantepec, El Limos (arriba de Chicozapote), *H. Hernández & R. Torres 311* (WIS); Paso Alicia, 8 km al NNW de Tehuantepec, *R. Torres, R. Cedillo & L. Rico 499* (CAS, MEXU, MO, MU); 2–4 km E of Tehuantepec on rd to Oaxaca (rt 190), *R. King 1154* (MICH, NY, TEX, UC, US); along hwy to Tehuantepec (rt 185), *R. King 239* (ENCB, MICH, TEX, US, WIS); cerro Guiengola, 11 km NO de Tehuantepec, *A. Campos 3754* (MEXU); Mun. de Asunción Ixtaltepec, *C. Gallardo & E. Pérez-García 1466* (MEXU); Mun. de Santiago Astata, Barra de la Cruz, *M. Elorsa 2199, 2227* (MEXU); Mun. Santo Domingo Tehuantepec, Ejido El Limón, *A. Reyes-García, J. Gordon & I. Sánchez 3305* (MEXU); El Limón, *I. Trejo 1175* (MEXU); Distr. Yautepec, El Camarón, *R. Torres, H. Hernández & P. Morales 5306* (MEXU); Distr. Juchitán, 17 km S de La Ventosa, *R. Cedillo 749* (CAS, MO); Distr. Pochutla, Mun. Santa María Huatulco, *A. Reyes-García & G. Ibarra 2692* (MEXU); Mun. de San Miguel de Puerto, *S. Salas, E. Torres, M. Cerón & R. García 1310* (MEXU); Distr. Jalapa del Marquez, camino Jalapa del Marquez-Santiago Lachigurri, *L. Cervantes 2168* (MEXU). **GUATEMALA. Zacapa:** aldea San Jorge, *G. Ventura V94.06* (MEXU); vic. Zacapa, *P. Standley 73570* (F); Paso de los Jalapa, *M. García & F. Ramírez 351* (MEXU). **HONDURAS. Francisco Morazan:** Mun. Morocelí, Quebrada Grande ± 1.5 km N de Morocelí, *J. Linares 5516* (MEXU). El Paraíso: Mun. Oropolí, 4 km al pueblo de Oropolí, *A. Molina 8585* (F, NY, WIS); el Abra, *S. Duery, G. Pilz, J. Linares & R. Martínez 19* (MEXU); drenaje del Río Choluteca, *A. Molina 8617* (F, NY, US, WIS). **NICARAGUA. Boaco:** La Cruz, km 60 carr. al Rama, *P. Moreno 21517* (WIS); 2 km al NE de Boaquito, *P. Moreno 16607* (HNMN, MO, WIS); W slope of Cerro Coyanchigua, *W. Stevens 22943* (MO, WIS); 6 km NE de la ciudad de Boaco, *A. Grijalva & M. Sandino 2775* (WIS); 1.6 km SW of Santa Cruz, *W. Stevens 22907* (MO, WIS); El Ojo de Agua, carr. Santa Lucia, *P. Moreno 10104* (WIS). **Managua:** ca. San Francisco Libre, *A. Laguna 246J* (MO); La Mojarra, *P. Moreno 21443* (WIS); vic. Hac. San Jacinto, NE of Managua, *H. Iltis & P. Anderson 30875a* (UWSP, WIS). Matagalpa: ca. 1.8 km SW of ford of Río Grande de Matagalpa, *W. Stevens 9818, 10918* (MO, WIS); entre Waswalí abajo y Waswalí arriba, *P. Moreno & W. Robleto 22899* (WIS); *W. Stevens & J. Henrich 20312* (MO, WIS), *W. Stevens & G. Schatz 21584* (MO, WIS); Camino viejo a Jinotega, *A. Grijalva & F. Ortiz 2826, 2828* (WIS); San Juanillo, ca. 8 km al SE de ciudad Darío, *A. Grijalva 2600* (WIS); entrada Paso de Carreta, *P. Moreno 16693* (WIS); carr. Panamericana, caserío Puertas Viejas, *P. Moreno 718* (WIS); La Aurora, Río Viejo, *M. Castro 132* (WIS); 3 km E de Puertas Viejas, *P. Moreno 20107* (WIS); ca. 1.8 km SW of ford of Río Grande de Matagalpa, rd. to Terrabona, *W. Stevens 9818* (MO, WIS). **Segovia:** Nueva Segovia, *Ørsted 3160* (C, C fragm. at WIS). **COSTA RICA. Guanacaste:** Cantón Liberia, Parque Nac. Santa Rosa, *R. Espinoza 462* (INB, WIS); 5 km de la Playa Naranjo, *N. Zamora 942* (F); slope below Questa, *R. Liesner, F. Almeda & R. Wilbur 3396* (MO); ca. 15 km SW of entrance, *R. Wilbur, F. Almeda & T. Daniel 22924* (DUKE); ca. 15.8 km beyond the entrance to Parque Nac. Santa Rosa, *F. Almeda, R. Wilbur & T. Daniel 108* (CAS); Santa Rosa, *R. Liesner 4617* (MO).

5b. Quadrella morenoi f. **hastata** Iltis, f. nov. TYPE: NICARAGUA: vic. Hac. San Jacinto, NE of Managua, stump sprouts from disturbed shrub and small tree savanna, ca. 100 m, 14 Oct 1991 (st), *H.H. Iltis & P. Anderson 30875* (HOLOTYPE: WIS; ISOTYPES: MO, NHNM, US).

Idem *Quadrella morenoi* Cornejo & Iltis, sed forma juvenilibus cum foliis prominentibus hastatis.

Juvenile branches of a few New World Capparaceae occasionally produce radically different, hastate leaves, in the case of *Q. morenoi* f. *hastata*, with the elongated, 4–15 cm long and 0.4–0.7 cm wide, slender and narrowly-oblong central lobe abruptly diverging at base into two, ± equal, laterally-projecting, rounded basal lobes, these together 1.2–4 cm wide from side to side, and with the whole leaf with as many as 17 main lateral veins on each side of the midrib.

It is of great interest that, while the eight stamens and short ovoid fruits of *Quadrella morenoi* suggest a close relationship to the eight staminate, short- and ovoid-fruited *Q. incana* and the other species of *Quadrella* subg. *Intutis*, its green embryos rather than white, and the frequent occurrence of hastate, juvenile, stump sprout leaves (which never occur in *Q. incana*), are more congruent with the similarly eight staminate, green-embryoned *Q. lundellii* (Standley) Iltis & Cornejo, a co-member of *Quadrella* subg. *Breyniastrum*, for which, despite its elongate capsules, its hastate juvenile leaves provide strong reinforcing evidence for this odd, putative relationship. Another species of subg. *Breyniastrum* with eight stamens, *Quadrella steyermarkii* (Standley) Iltis & Cornejo, nevertheless, does not produce juvenile hastate leaf blades, but rare as it is, they may yet turn up!

Finally, the occurence of these peculiar leaf forms in *Quadrella morenoi* is reminiscent of the analogous situation in the distantly related *Cynophalla hastata* (Jacq.) J. Presl. However, it is important to note that there is no close relationship whatever between these two genera of American Capparaceae.

PARATYPES: **MEXICO. Michoacan:** 4 mi NW of Apatzingán, *R. McVaugh 17924* (MICH, WIS); 13 km W of Apatzingán, *J. Rzedowski 22303* (ENCB, MEXU, WIS). Oaxaca: Chivela, *C. Mell 35* (US, US fragm. at WIS); Mun. Santo Domingo Tehuantepec, Ejido El Limón, *A. Reyes-Garcia, J. Gordon & I. Sánchez 3305* (MEXU). **GUATEMALA.** Zacapa: vic. Zacapa, *P. Standley 74179* (F), *P. Standley 74624* (GH, F [2], NY, US). Chiquimula: Between Ramirez and Cumbre de Chiquimula, *P. Standley 74543* (F, US); near the divide, rd. from Chiquimula to Zacapa, *P. Standley 71969* (F [2], US). **NICARAGUA.** Boaco: 1 km E de Santa Cruz, *W. Stevens 22916* (WIS). Hac. San Antonio, carr. a Boaquito, *P. Moreno 21545* (MO). **COSTA RICA. Guanacaste:** Parque Nac. Santa Rosa, Sendero Carbonal, *A. Fernández 296* (INB).

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BOOK REVIEW

S.M. Walters and E. A. Stow. 2009. **Darwin's Mentor: John Stevens Henslow, 1796–1861.** (ISBN 978-0-521-11799-9, pbk.). Cambridge University Press, 100 Brook Hill Drive, West Nyack, New York, 10994-2133, U.S.A. (**Orders:** www.cambridge.org, 1-845-353-7500). $36.99, 338 pp. including 77 pp. of appendices, endnotes, bibliography, and index, 6 3/4" × 9 5/8".

When I picked up *Darwin's Mentor* I was looking forward to reading about a man who influenced/mentored Darwin, reading about their professional and personal relationships and learning more about each of these individuals. I was disappointed.

Just about the first thing I noticed about this book was actually something that had nothing to do with the content. The margins are so out of balance that it has the effect of making reading difficult. The inside margin is 15 mm and the outside margin is 40 mm! It has been suggested that this was deliberate, leaving room for making notes in the margin. Perhaps, if this was intended as a textbook, that could make some sense. For an ordinary reader, however, it is very distracting.

At the beginning of the book, the authors quote Charles Darwin from a letter written to Joseph Hooker, who perhaps was thinking of writing about Henslow. In his letter Darwin noted he could not "…help feeling doubtful, on the principle that a biography could not do him justice." Further noting, "I cannot help fearing his life might turn out flat. There can hardly be marked incidents to describe.—I sincerely hope that I take a wrong & gloomy view, but I cannot help fearing I would rather see no life that one that would interest very few." After reading the book, I rather felt Darwin was prescient in his evaluation.

It seems that Henslow was intelligent and well thought-of by his peers and his students. His most meaningful work may have been as Rector to Hitcham. He worked to improve the lives of the peasant folk in his parish to good effect and was, in the end, well regarded by them. However, the dearth of direct letters to and from Henslow or any sort of journal or items from local publications concerning him leaves this reader with little feeling for who the man was or how he influenced Darwin. In the end, even Darwin noted that Henslow's strong suit was his "ability…to draw conclusions based on…minute observations, but he didn't possess…much original genius."—*Kay Yount, Tarrant County Master Gardener, BRIT Volunteer, Fort Worth, Texas, U.S.A.*

STUDIES IN CAPPARACEAE XXVIII: THE *QUADRELLA CYNOPHALLOPHORA* COMPLEX

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ABSTRACT

Quadrella (DC.) J. Presl (1825) is a West Indian and Mesoamerican, dehiscent-fruited genus (Capparaceae) of 25 species covered with complex, variously branched or fused trichomes, was recently resuscitated from the breakup of the New World *Capparis* L., s.l. Within *Quadrella*, the lepidote or peltate pubescent complex of *Q. cynophallophora* (L.) Hutchinson includes two closely related, taxonomically problematic species and subspecies groups: *Q. cynophallophora* of the West Indies (with outlier populations in Florida and the Yucatan Peninsula) and *Q. isthmensis* (Eichler) Hutchinson in Mesoamerica. The former includes *Quadrella cynophallophora* s.s., widespread from the Bahamas through Hispaniola to Trinidad; *Q. jamaicensis* (Jacq.) J. Presl, from southern Florida to Hispaniola; **Quadrella quintanarooensis** Iltis & Cornejo, sp. nov., a local endemic of Cozumel Island and adjoining northeastern Yucatan in Mexico; *Quadrella gonaievensis* (Helwig) Hutchinson, a rare species of Hispaniola; and **Q. siliquosa** (L.) Iltis & Cornejo comb. nov., a montane endemic of Jamaica. From the American Virgin Islands, we describe two juvenile forms, **Quadrella cynophallophora** f. **linearifolia** Iltis, f, nov., and another from Jamaica, transferred from *Capparis*, **Quadrella jamaicensis** f. **longifolia** (Sw.) Iltis, comb. nov. The second group of taxa consists of *Quadrella isthmensis* (Eichler) Hutchinson, which we divide into three subspecies: *Q. isthmensis* subsp. *isthmensis* of Costa Rica and coastal Panama, **Q. isthmensis** subsp. **glabripetala** Cornejo & Iltis, subsp. nov., of Panama's Cordillera Central, and **Q. isthmensis** subsp. **mexicana** Cornejo & Iltis, subsp. nov., disjunct to Mexico's Yucatán Peninsula. The following taxa are lectotypified: *Quadrella cynophallophora* (L.) Hutchinson, *Q. jamaicensis* (Jacq.) J. Presl, and *Q. isthmensis* subsp. *isthmensis* (Eichler) Hutchinson. Finally, *Quadrella siliquosa* (L.) Iltis & Cornejo and its synonym *Capparis torulosa* Sw. are both neotypified. Descriptions, keys to taxa, distribution maps and illustrations are provided.

Key Words: Capparaceae, *Quadrella*, Mesoamerica, Mexico, West Indies, Florida

RESUMEN

Quadrella (DC.) J. Presl (1825) es un género (Capparaceae) de las Indias Occidentales y Mesoamérica, recientemente resucitado de *Capparis* L., s.l., que comprende 25 especies caracterizadas por presentar complejos tricomas peltados a estrellados y frutos dehiscentes. En *Quadrella*, el complejo lepidoto o peltado *Q. cynophallophora* (L.) Hutchinson está compuesto por dos grupos de especies y subespecies taxonómicamente problemáticas y cercanamente relacionadas entre sí: *Q. cynophallophora*, principalmente distribuida en las Indias occidentales (con poblaciones en Florida y la Península de Yucatán); y *Q. isthmensis* (Eichler) Hutchinson, en Mesoamérica. *Q. cynophallophora* comprende *Q. cynophallophora* s.s., ampliamente distribuida desde Bahamas, a través de La Española hasta Trinidad; *Q. jamaicensis* (Jacq.) J. Presl, distribuida desde el sur de Florida hasta La Española; **Q. quintanarooensis** Iltis & Cornejo, sp. nov., una endémica local, de la isla Cozumel y la porción costera adyacente en el noreste de la Península de Yucatán, en Méjico; *Q. gonaievensis* (Helwig) Hutchinson, una rara endémica de La Española; y **Quadrella siliquosa** (L.) Iltis & Cornejo, comb. nov., endémica de las montañas de Jamaica. Describimos dos formas juveniles, **Quadrella cynophallophora** f. **linearifolia** Iltis, f. nov., de las islas Vírgenes y, **Quadrella jamaicensis** f. **longifolia** (Sw.) Iltis, comb. nov. es transferida de *Capparis*. El segundo grupo, estrictamente Mesoamericano, está compuesto por las tres subespecies de *Q. isthmensis* (Eichler) Hutchinson: *Q. isthmensis* subsp. *isthmensis* distribuida en Costa Rica y la costa de Panamá, **Q. isthmensis** subsp. **glabripetala** Cornejo & Iltis, subsp. nov., endémica de la Cordillera Central, en Panamá, y **Q. isthmensis** subsp. **mexicana** Cornejo & Iltis, subsp. nov., disyunta a la Península de Yucatán, en Méjico. Las siguientes taxa son lectotipificadas: *Quadrella cynophallophora* (L.) Hutchinson, *Q. jamaicensis* (Jacq.) J. Presl, y *Q. isthmensis* subsp. *isthmensis* (Eichler) Hutchinson. Finalmente, *Quadrella siliquosa* (L.) Iltis & Cornejo y su sinónimo *Capparis torulosa* Sw. son neotipificadas. Se provee una clave de identificación, descripciones, mapas de distribución e ilustraciones.

The almost exclusively West Indian-Mesoamerican genus *Quadrella* (DC.) J. Presl (1825), emended herein, is one of only two stellate to lepidote or peltate pubescent New World genera of Capparaceae with dehiscent fruits. *Quadrella*, a genus of 25 species, is characterized by a valvate calyx with four sepals in a single series. These may be 1), either very small and triangular with an open calyx aestivation long before anthesis in *Quadrella* subg. *Breyniastrum* (DC.) Iltis and half of the species of *Quadrella* subg. *Intutis* (Raf.) Iltis,

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(*Quadrella domingensis* [Sprengel ex DC.] Iltis & Cornejo, *Q. ferruginea* [L.] Iltis & Cornejo, and *Q. incana* [Kunth] Iltis & Cornejo); 2), or with a closed calyx aestivation, i.e., temporarily fused and closed over the petal buds until or nearly to anthesis in subg. *Quadrella* and in the remaining species of *Quadrella* subg. *Intutis* (*Q. angustifolia* [Kunth] Iltis & Cornejo, *Q. alaineana* Cornejo & Iltis & *Q. singularis* [R. Rankin] Iltis & Cornejo) [Iltis & Cornejo 2010]).

Our view of the systematics of the *Quadrella cynophallophora* (L.) Hutch. complex, a taxonomical and nomenclaturally difficult group, is to place heavy emphasis not only on morphology of leaves, flowers and fruits but also on the mostly allopatric geographic distribution of its taxa. Thus, our systematic viewpoint is the exact opposite of that of the first author's former major professor, the late Robert E. Woodson, who in his treatment of Capparaceae for the Flora of Panama (1948) lumped all four of the then recognized taxa into one, all-encompassing *Capparis cynophallophora* without any further discussion. We, on the other hand, recognize the morpho-geographic reality and split this complex into several allopatric species and subspecies (Fig. 1), based on either *Quadrella cynophallophora* or *Q. isthmensis*. An exception lies in the *Q. jamaicensis* J. Presl–*Q. cynophallophora* geographic overlap in Hispaniola, and rarely with a *Q. jamaicensis* plant seen in the Bahama Islands, both of which are recognized herein as separate species based on their characteristic leaf shapes.

TAXONOMIC TREATMENT

Quadrella (DC.) J. Presl in Berchtold & J. Presl, Prir. Rostlin 2:260. 1825. Basionym: *Capparis* sect. *Quadrella* DC., Prodr. 1: 251. 1824. *Capparis* subg. *Quadrella* (DC.) Eichler in Martius, Fl. Bras. 13(1):269. 1865. Type: *Quadrella jamaicensis* (Jacq.) J. Presl (=*Capparis jamaicensis* Jacq.), neotype designated by Iltis & Cornejo 2010.

KEY TO THE *QUADRELLA CYNOPHALLOPHORA* COMPLEX

1. Ovaries at anthesis 3–6.5 mm; sepals 5–10(–11) mm; receptacle in fruits (2–)3–5 (–6) mm wide; stamens 16 to 35 (–40); leaf blades mostly lustrous above, usually uniformly lepidote or peltate, green or brownish-green beneath; Florida, through the West Indies to Trinidad and Barbados, disjunct to Mexico's Yucatan Peninsula (Cozumel Island and Quintana Roo) **I. Cynophallophora** alliance (five species)

  2. Flowers large, with petals 8–17 mm and sepals (5–)7–11 mm; stamens with simple or few-branched stellate trichomes at filament bases; anthers (2–)3–4 mm; southern Florida, West Indies, and in Mexico from the northeastern Yucatan Peninsula.

    3. Gynophores conspicuous, 10–50 mm in flowers, to 80 mm in fruits; filaments 20–50 mm; petals 10–17 mm; common, the West Indies and southern Florida.

      4. Leaf blades 3–8(–10) × 1–4(–4.5) cm, elliptic to narrowly obovate or oblong, rarely lanceolate (linear-lanceolate [to 17 cm] in juvenile leaves or stump sprouts), stiffly coriaceous and revolute, lustrous above; petioles 1–2 cm; seeds 5–8 × 4–6 mm, packed into mostly barely torulose capsules; throughout the West Indies and southern Florida, in Jamaica mostly in coastal lowlands.

        5. Leaf blades ± elliptic, mostly 5–10 × 2–6 cm, with the apex acuminate or acute, sometimes obtuse to rounded but then often apiculate and not emarginate; central and eastern West Indies (Bahamas and Hispaniola to Puerto Rico, Trinidad and Barbados, sympatric with the following in Hispaniola) **1. Quadrella cynophallophora** (L.) Hutchinson

        5. Leaf blades mostly oblong or oblong-elliptic, mostly 3–7(–9) × 1–3(–3.5) cm, with the apex usually emarginate (notched) to rounded; southern Florida, Cuba, coastal Jamaica, Cayman and Swan Islands, sympatric with preceding species in Hispaniola, rarely in the Bahamas **2. Quadrella jamaicensis** (Jacq.) J. Presl

      4. Leaf blades 7–15(–20) × 4–9 cm, ± broadly elliptic, ± chartaceous, rather opaque above, on petioles (1.5–)2–4 cm; seeds 7–15 × 6–9 mm, spaced out in strongly torulose capsules; highlands of Jamaica at 200–800 m **3. Quadrella siliquosa** (L.) Iltis & Cornejo

    3. Gynophores in flowers and fruits highly reduced, to 5 mm or less or lacking; filaments 6–15 mm; petals 8–9 mm; endemic to Mexico (Cozumel Island and Quintana Roo, northeastern Yucatan Peninsula) **4. Quadrella quintanarooensis** Iltis & Cornejo

  2. Flowers small, delicate, with petals 6–7 mm and sepals 5 mm; stamens with densely lepidote-radiate or lepidote-stellate (many-branched) trichomes at filament bases; anthers 1–2 mm; very rare, scattered eastern half of Hispaniola (Haiti and eastern-most Dominican Republic) **5. Quadrella gonaievensis** (Helwig) Hutchinson

1. Ovaries at anthesis 6.5–10 mm; sepals (9–)10–18 mm; receptacle in fruits 5–10 mm wide; stamens ca. 30 to 60; leaf blades opaque above (except *Quadrella isthmensis* subsp. *mexicana*), silvery lepidote-peltate beneath, with scattered darker bronze hairs giving the lower surface a peppered appareance; Panama and Costa Rica, disjunct westward to the central Yucatan Peninsula (northern Guatemala and Belize), and north to the Caribbean coast of Mexico's Yucatan________________________ **I. Isthmensis** alliance (one species and three subspecies)
    6. Petals densely lepidote without, sepals tomentose within; eastern Mexico (northern Yucatan and Campeche) south into Guatemala and Belize, disjunct to Costa Rica and lowlands of Panama.
        7. Flowers larger, with petals 12–18 × 7–10 mm, stamens 4–7 cm, and gynophores 4–8 cm; fruits to 60 cm, on gynophores 4–8 cm and pedicels (1.3–)2–4.5 cm; leaf blades dull above when dry; Costa Rica and lowlands of Panama ____________________ **6. Quadrella isthmensis** subsp. **isthmensis** (Eichler) Hutchinson
        7. Flowers smaller, with petals 9–13 × 6–7.5 mm, stamens 2–4(–4.5) cm and gynophores 1–4.5 cm; fruits to 23 cm, on gynophores 2–4(–5.5) cm and pedicels 1–2 cm; leaf blades often lustrous above when dry; Mexico (northern and central Yucatan Peninsula) to adjacent Guatemala and Belize_____________ **7. Quadrella isthmensis** subsp. **mexicana** Cornejo & Iltis
    6. Petals completely glabrous without, sepals tomentulose within; very rare, crest of the Cordillera Central of western Panama___________________________________ **8. Quadrella isthmensis** subsp. **glabripetala** Cornejo & Iltis

1a. Quadrella cynophallophora (L.) Hutchinson, Gen. Fl. Pl. 2:309. 1967. (**Figs. 1–3**). Basionym: *Capparis cynophallophora* L., Sp. Pl. ed. 1: 504. 1753. Type: JAMAICA?: Left hand specimen, "*Capparis* 2," Hortus Cliffortianus Hb. (lectotype, designated here, BM-628728).

Shrubs or trees to 5(–10) m tall, to 40 cm dbh, rusty-brown peltate-lepidote throughout, the branchlet tips and peduncles flattened. Leaves ± coriaceous, evergreen, dark-green, often lustrous and glabrous above, densely covered with light golden brown (sometimes with scattered darker, rusty-brown) peltate-lepidote hairs beneath, ± elliptic to obovate, rarely lanceolate, acuminate or acute to rounded, often apiculate, cuneate to widely rounded at base (excluding the linear [to 15 × 2 cm] juvenile or stump sprout leaves), (3–)5–10 × 1.5–4.6 cm, the midrib sulcate above, the secondary nerves inconspicuous; petioles 0.5–2(–3.5) cm, canaliculate. Inflorescences terminal in leaf axils at ends of branches, subcorymbose, 1- to 7-flowered, the linear bracts ca. 2 mm, soon caducous; peduncles and stout 7–40 mm pedicels flattened, rusty-brown, densely lepidote; flower buds ovoid to lanceolate, pointed, longitudinally ± 4-ribbed; sepals at anthesis reflexed, ovate to lanceolate, 5–11 × 3–6 mm, densely rusty lepidote without, tomentose to tomentulose within; nectar scales flat, 1–2(–3.5) mm; petals divergent at anthesis, creamy white, soon fading (as do the stamens) to a pink or dark purplish violet, elliptic-obovate, about as long as the sepals, usually densely-lepidote without, glabrous within; stamens 20–35(–40), the filaments 2.5–5 cm, densely pilose with simple, usually white trichomes at the very base, the anthers 2–3.5 mm; gynophores 1.5–5 cm, glabrous, on androgynophores 1–1.5 mm; ovaries linear-cylindric, 3–7 mm, densely peltate-lepidote, the stigma truncate. Fruits linear-cylindric ± torulose siliquiform capsules, 4–40 × 0.4–1 cm, brown, densely lepidote, ± irregularly rupturing along (usually) one suture, the valves turning inside out to expose their bright orange to scarlet pulpy endocarp and the embedded bright orange to reddish arillate seeds, these often dangling from the replum by a thin funicular thread; gynophores (1–)1.6–8 cm, glabrous, clearly demarcated from fruit valves; receptacular disks in fruit, (2–)3–5(–6) mm diam.; pedicels 1.5–4 cm, lepidote; seeds (2–)5 to 40, oblongoid, 5–8[–10 mm in Hispaniola] × 4–6 mm, with a bright orange aril and thin testa, the embryo green throughout, much folded.

The lectotype of *Quadrella cynophallophora* was selected by Fawcett and Rendle (1914a: 142) with the statement that "*Capparis cynophallophora* L., Sp. Pl. 504 is based on the plant (sic!) *Capparis* 2 of *Hortus Cliffortianus* 204: Linnaeus merely repeats the diagnosis from the earlier work." However, unfortunately, *Capparis* 2 in the Hortus Cliffortianus Herbarium (Fig. 2) is a mixed collection, with the left hand specimen a branch of *Quadrella cynophallophora* labeled "*Capparis* 2" [and which we explicitly designate as the lectotype of that species], and the right hand branch clearly belonging to *Quadrella jamaicensis* (Jacq.) J. Presl (small, narrow, emarginate leaves, etc…), and simply another collection of that common coastal Jamaican species. No matter what Linnaeus (Anonymous 1933: 204) may say in Hortus Cliffortianus ("*Capparis*…foliis, ovalibus…"), he cites as his only reference Plukenet "Alm. 126. t. 172, f. 4" with "…foliis subrotundis…" from Barbados, this a drawing with typical *Q. cynophallophora* leaves.

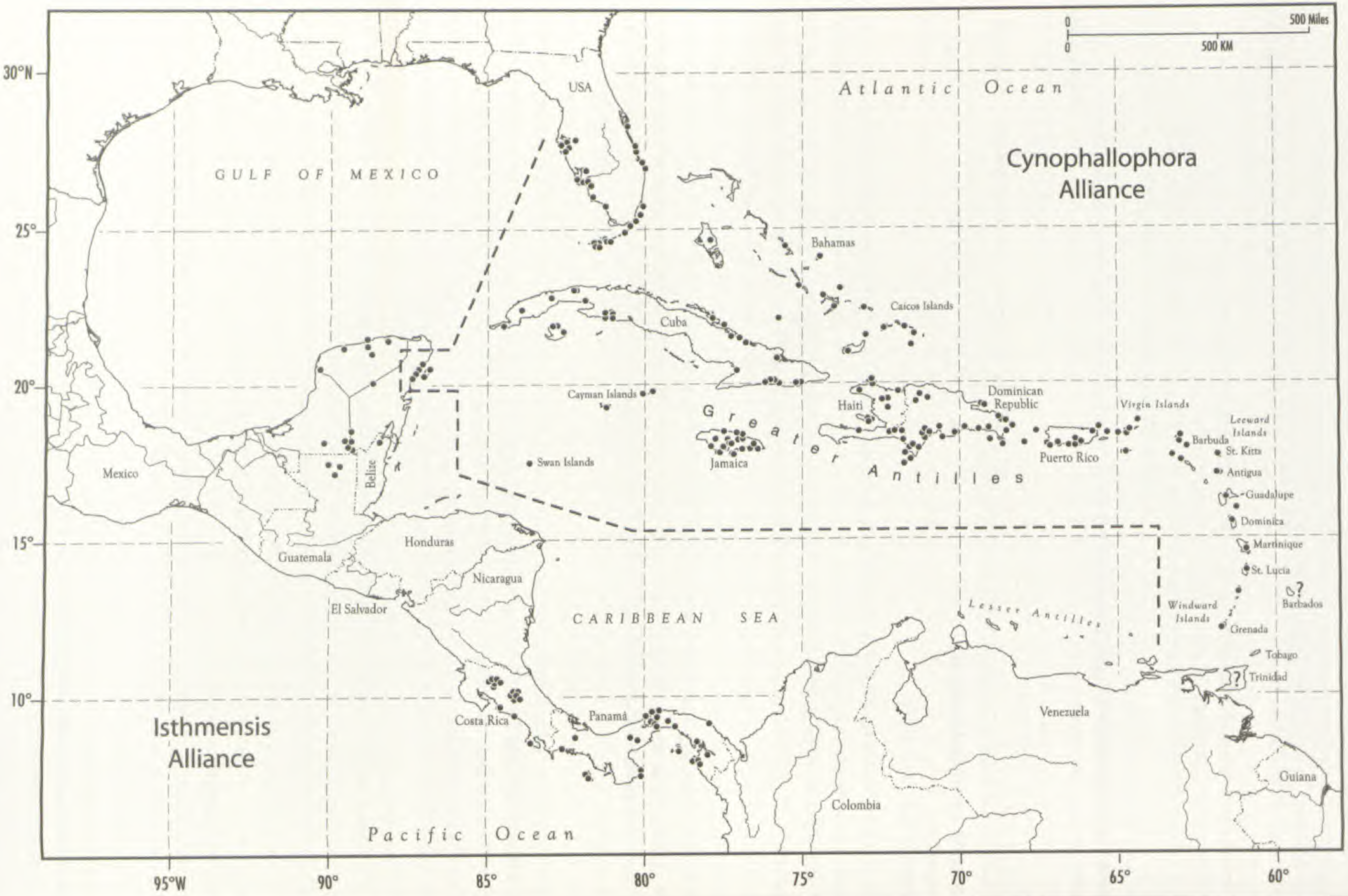
0
500 Miles
0
500 KM
30°N
25°
20°
15°
10°
95°W
90°
85°
80°
75°
70°
65°
60°
Atlantic Ocean
Cynophallophora Alliance
GULF OF MEXICO
USA
Bahamas
Caicos Islands
Cuba
Cayman Islands
Swan Islands
Greater Antilles
Jamaica
Haiti
Dominican Republic
Puerto Rico
Virgin Islands
Leeward Islands
Barbuda
St. Kitts
Antigua
Guadalupe
Dominica
Martinique
St. Lucia
Barbados
Windward Islands
Grenada
Tobago
Trinidad
Lesser Antilles
Mexico
Belize
Guatemala
Honduras
Nicaragua
El Salvador
CARIBBEAN SEA
Costa Rica
Panamá
Venezuela
Colombia
Guiana
Isthmensis Alliance
Pacific Ocean

FIG. 1. Phytogeography of the *Quadrella cynophallophora* complex: The *Cynophallophora* group, ranging from southern Florida and the Bahamas through Jamaica and Hispaniola to Trinidad, and, disjunct, to Cozumel Island and adjoining mainland of the Yucatan Peninsula of Mexico; and the Mesoamerican *Quadrella isthmensis* group, ranging from Panama to Costa Rica and, disjunct, to the Yucatan Peninsula of Mexico, Guatemala and Belize.

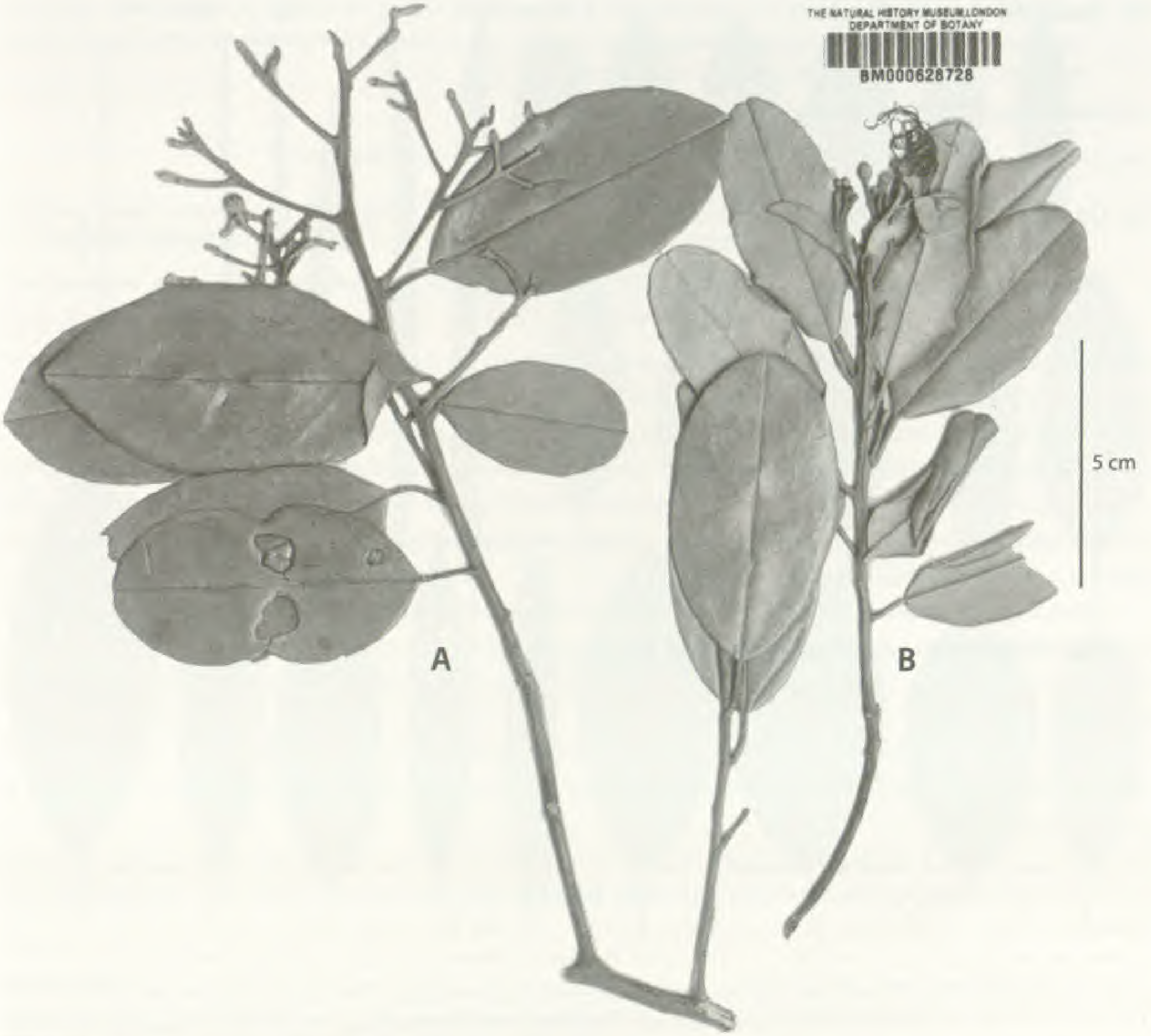

Fig. 2. Hortus Cliffortianus Herbarium "*Capparis* 2" sheet (BM), a mixed collection with the left hand specimen the lectotype of *Quadrella cynophallophora*, and the right hand specimen a typical branch of *Quadrella jamaicensis*. Legend at bottom of left side, "p. 204 *Capparis 2*," refers to page 204 and the second *Capparis* listed in *Hortus Cliffortianus* (Anonymous 1937). Text in center reads "*Capparis jamaicensis* Jacq." on the top line and "*Capparis cynophallophora* L." on the bottom line.

Habitat and Distribution.—Central and eastern West Indies, from the Bahamas to Hispaniola (where it intergrades with *Quadrella jamaicensis*) and to the southern coast of Puerto Rico and through the Lesser Antilles to Trinidad and Barbados (Gooding et al. 1965), mostly in coastal, seasonally dry, evergreen woodlands, but also in a great variety of habitats, and often cultivated as hedges.

Phenology.—Flowering from April to January, fruiting throughout the year.

Vernacular names.—BARBADOS: Black Willow (*E. Gooding 39*, WIS); DOMINICAN REPUBLIC: Frijol (*Valeur 403*, WIS), Frijolillo (*J. Schiffino 167*, WIS), Olivo (*J. Schiffino 27*, WIS).

Selected specimens: **U.S. Virgin Islands:** St. Croix, Big fountain, *A. Ricksecker* (MU); St. Thomas, Water Bay, *Eggers 417* (CAS); St. John, East End Quarter, *P. Acevedo-Rodriguez et al. 1821* (WIS). **Puerto Rico:** El Tuque, near Ponce, *H. Alain & P. Lioger 31206* (UPR); Salinas de Cabo-Rojo, *P. Sintenis 578* (M); Mun. Manati, near Ciales, rte 632 near rte 149, *C.M. Taylor et al. 7993* (NY); Mun. Guanica, Reserva Forestal Guanica, *H. Iltis 30314* (WIS). **Dominican Republic:** Sierra de Neiba, Prov. Independencia, Cerros del Cao, *T. Zanoni et al. 24814* (WIS); Peninsula de Barahona, Prov. Pedernales, 8 km sur del puerto de Cabo Rojo de Alcoa Expl. Co., *T. Zanoni & J. Pimentel 26357* (WIS). **Guadeloupe:** Grande Terre, L'Auter Bord distr., E of Le Moule, *G. Proctor 19916* (WIS). **Antigua:** St. Paul, Shirley Heights, *G. Webster 13598* (WIS). **St. Maartens:** near top of Sentry Hill, *A. Stoffers 4526* (A). **Barbados:** Newton, Christ Church, *E. Gooding 39* (WIS).

1b. Quadrella cynophallophora (L.) Hutchinson, f. **linearifolia** Iltis, f. nov. (**Fig. 3, upper left**). Type: U.S.A. Virgin Islands: St. John, East End Quarter, Hansen Bay, 0–10 m, dry scrubby coastal environment along a rocky shore, *P. Acevedo-Rodriguez, A Reilly & M. Davis 1808* (holotype: NY, NY photocopy at WIS).

A *Quadrella cynophallophora* forma juvenilibus cum lamina linearis.

Distribution.—This form is found across the range of *Quadrella cynophallophora*.

2a. Quadrella jamaicensis (Jacq.) J. Presl, Prir. Rostlin 2:261. 1825. (**Figs. 2B, 5A**). Basionym: *Capparis jamaicensis* Jacq., Enum. Syst. Pl.: 23. 1760. Type: JAMAICA: tab. 101 in Jacquin, 1763 (lectotype, designated by Al-Shehbaz 1988: 296).

Capparis emarginata A. Rich. in Sagra, Hist. Fís. Cuba 10:28, tab. 9. 1845, syn. nov. Type: CUBA: Sagra (P) (lectotype designated by Al-Shehbaz in Flora of the Lesser Antilles-Dicotyledoneae 4(1):296. 1988).

Shrubs to small trees, peltate-lepidote throughout [except for the narrower, smaller leaves, very similar to *Quadrella cynophallophora*]. Leaf blades mostly oblong to oblong-elliptic, 3–9(–11) × 1–3.5 cm, with apex emarginate or notched to rounded, hard, shiny above, margin revolute; petioles 0.7–1.6 cm. Seeds 5–7 × 4–5 mm.

Habitat and Distribution.—This common coastal species is found in the United States in Florida (from Cape Cañaveral on the east coast and St. Petersburg Beach on the west coast, south to Key West), Cuba, coastal Jamaica, and the Cayman and Swan Islands, intergrading with *Quadrella cynophallophora* on Hispaniola, and rarely in the Bahamas.

Phenology.—Flowering from March to August, fruiting from June to October.

Vernacular names.—FLORIDA. Jamaica caper (*D. Caldwell 8779*, WIS), Black wattle, Black willow. CUBA. Carbonero, Ciguarayo, Mostaza, Mostacilla, P[enis] de perro (*Roig & Mesa 1945*), Moruro Prieto (*Bro. León & T. Roig 11429*, WIS).

Due to the ubiquitous confusion with the common *Quadrella cynophallophora* and the montane *Q. siliquosa* on Jamaica, we have chosen to cite only a few representative collections of *Q. jamaicensis* across its distributional range.

Selected specimens: **U.S.A. FLORIDA: Monroe Co.:** Florida Keys, Key West, *A. Curtis 204* (BM, BKL, K, UT). **St. Lucie Co.:** ca. 2 mi S of hwy 712 on 707, S of Ft. Pierce, *R. Wunderlin et al. 10153* (WIS). **Dade Co.:** Miami, Fairchild Trop. Garden, cult., *H.H. Iltis 28580* (WIS). **Martin Co.:** E bank, St. Lucie River, E of Stuart, *R. Kral 49263* (PH, VDB). **Lee Co.:** Sanibel Island, *G. Cooley 2320* (USF); J.N. "Ding" Darling Nat. Wildlife Refuge, *R. Wunderlin et al. 6278* (USF). **Pinellas Co.:** Madeline Key (Hospital Key), Fort De Soto Park, *R. Thorne 33896* (IJ, RSA, USF, WIS). **Brevard Co.:** Malabar Cape, S of Melbourne beach, *O. Lakela 28669* (DS, MEXU, USF, WIS). **Hillsborough Co.:** Cockroach Bay, Indian Shell Mound, *S. Mortellaro 8* (USF). **Palm Beach/Martin Co.:** Jupiter Island, *G. Cooley et al. 4875* (USF). **Sarasota Co.:** Sarasota, Longboat Key, *O. Lakela & D. Laker 28686* (USF). **CUBA. Santa Clara:** Soledad State, Gavilán, *J. Jack 5715* (WIS [MAD 16674]). Cienfuegos Bay, Punta Diablo, *N. Britton & P. Wilson 5671* (NY). **Las Villas:** Vic. Soledad, *A. Gonzáles 594* (BM, FLAS, GH, IJ). **Isle of Pines:** Base of Sierra de Casas, *Bro. Alain & E. Killip 2261* (GH, IJ). **Habana:** Near Batabanó, *Bro. Alain 770* (IJ, US). **Pinar del Río:** Vic. Sumidero, *J. Shafer 13516* (NY, PH, US). **Oriente:** Guantánamo Bay, U.S. Naval Station, woodlands, seaward point, *N. Britton 2189* (NY). **Guantánamo:** Imias, *R. Dechamps et al. s.n.* (BR, 12335). **Without locality:** *Wright 1870* (B, BM, GH, GOET, K, MO, NY, US, WIS fragm.). **CAIMAN ISLANDS. Caiman Brac:** betw. Hawksbill Bay & Goat Bay, S side, *G. Proctor 29138* (IJ). **Grand Caiman:** near Sand Bluff, E end, *M. Brunt 2002* (IJ). **Little Caiman:** 0.5 km W of Sparrowhawk hill, *G. Proctor 35214* (IJ). **JAMAICA. Clarendon Parish:** Portland Ridge, *A. Loveless 2272* (OFH). **St. Elizabeth Parish:** near Calabash Bay, *R. Thorne & G. Proctor 48030* (NY, WIS). **Without Province:** Cane River Valley, *W. Harris 9630* (BM, GH, K, MEXU, US). **SWAN ISLANDS.** Great Swan, *G. Proctor 32521* (IJ). Little Swan, *G. Clough 2* (IJ). **BAHAMAS. Long Island:** Clarence Town, *S.R. Hill 2295* (VT).

2b. Quadrella jamaicensis (Jacq.) J. Presl, f. **longifolia** (Sw.) Iltis, comb. et stat. nov. (**Fig. 4**). Basionym: *Capparis longifolia* Sw. Prodr. (Swartz) 81. 1788. Type: JAMAICA: *Swartz s.n.* (holotype: S! [WIS photo]; isotype: C! [IJ, WIS photo]).

This strikingly different form is evidently a stump-sprout or sterile, juvenile branch with narrow elongate leaf blades, common in this species and, in a homologous form, also in *Quadrella cynophallophora* f. *linearifolia* but apparently lacking in *Q. siliquosa*. *Quadrella jamaicensis* f. *longifolia* was illustrated by Plukenet (1696 tab. 327, fig. 6 p.p., the leafy branch only).

Distribution.—This form occurs across the range of *Quadrella jamaicensis*.

3. Quadrella siliquosa (L.) Iltis & Cornejo, comb. nov. (**Figs. 5B, 6**). Basionym: *Capparis siliquosa* L., Syst. Nat. ed. 10(2):1071. 1759. [*pro parte*]. *Pleuteron siliquosa* (L.) Raf., Sylva Tellur. 109. 1838. Type: JAMAICA: road to Troy, 18 Sep 1906, *W. Harris 9488* (neotype, selected here: BM; isotypes: A, GH, K, NY, US, WIS [fragm.].

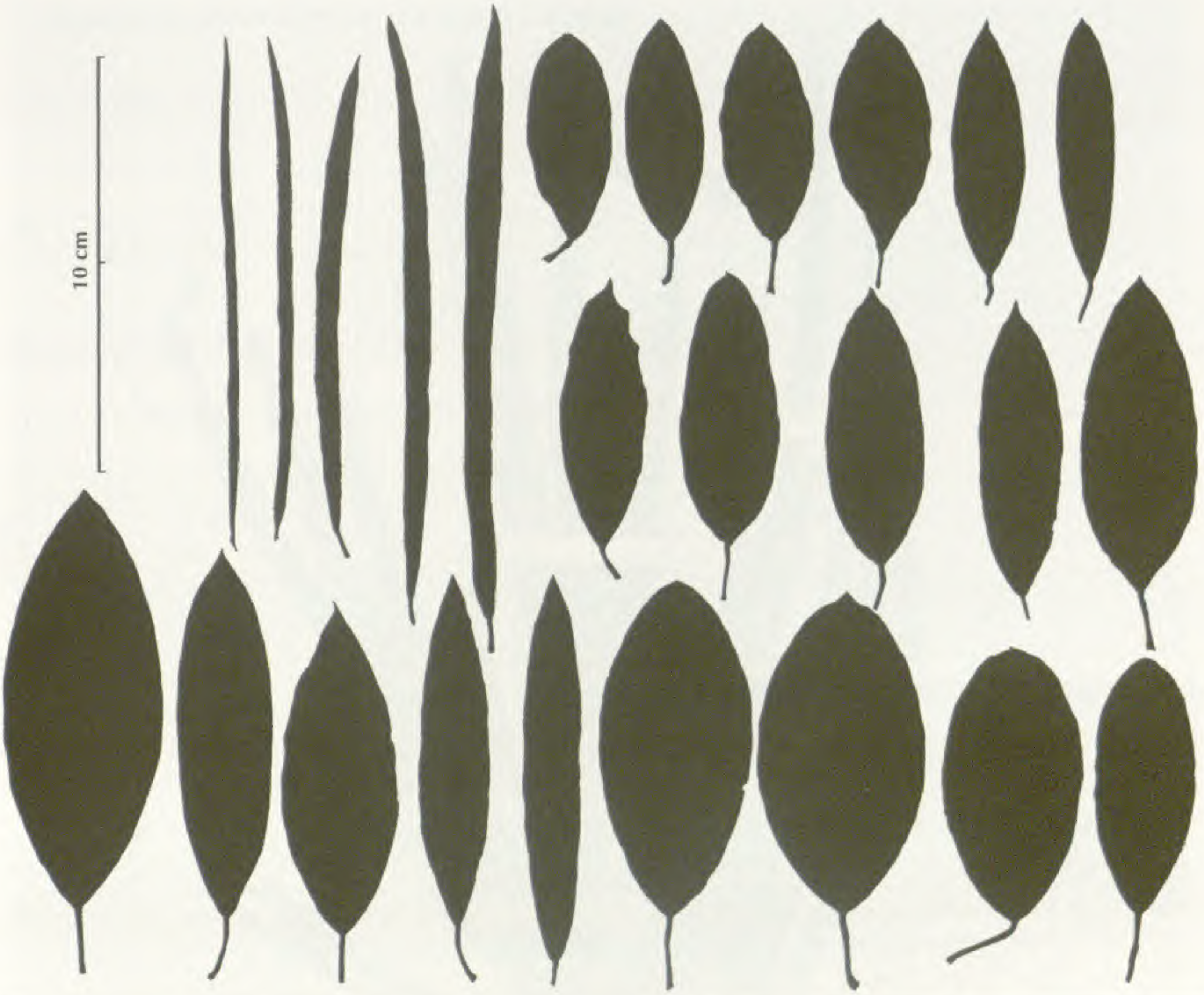

Fig. 3. Leaf blades shape variability in *Quadrella cynophallophora* on St. Maartens (of the former Dutch West Indies). Upper left: Stump sprout leaves, *Quadrella cynophallophora* f. *linearifolia* Iltis, all others, typical *Q. cynophallophora*, one leaf/collection (ex herb. Utrecht).

Capparis torulosa Sw., Prodr. 81. 1788. *Quadrella torulosa* (Sw.) J. Presl, Prir. Rostlin 2: 261. 1825. *Pleuteron torulosa* (Sw.) Raf., Sylva Tellur. 109. 1838. Type: Jamaica, s.d. (fr), *C. Wright s.n.* (neotype, designated here, S-05-9708, S photo at WIS).

Large shrubs or trees to 15 m tall, to 40 cm dbh, with dense bushy foliage. Leaves ± broadly elliptic, acute to abruptly short acuminate to almost rounded to the tip, broadly cuneate to rounded at base, 7–15(–20) × 4–9 cm, thinly coriaceous with mostly flat, occasionally revolute margins, glabrous above, peltate-lepidote beneath; petioles (1.5–)2–4 cm. [Juvenile leaves or stump sprouts not long and linear, as in both *Q. cynophallophora* and *Q. jamaicensis*]. Inflorescences small terminal corymbs or if lower, subterminal in the leaf axils; peduncles complanate-angulate, 3–6.5 cm, each bearing 3 to 7 flowers; pedicels 1–2 cm. Sepals lanceolate, 7–10 × 5 mm, densely rusty lepidote without, tomentose within; nectar scales flat, one each projecting from the sepal inner base, ca. 1–2 mm; petals 9–13 × 5–6 mm, divergent at anthesis, creamy white, densely lepidote outside, glabrous within; filaments ca. 3–5 cm, anthers ca. 3 mm; gynophores 2–5.5 cm, ovaries ca. 4 mm. Fruits disctinctly torulose siliquiform capsules, (3.5–)10–36 × ca. 1–1.2 cm, on gynophores (3.5–)5–8 cm; pedicels 1.2–2 cm; receptacles ca. 5 mm; seeds (1–)5–15(–20) or more per fruit, 7–15 × 6–9 mm, separately spaced out, covered by a red aril embedded in red endocarp.

Both *Quadrella siliquosa* and *Q. torulosa* are based on the same polynomial, *Breynia 2. Arborescens, foliis ovatis utrinque acuminatis, siliqua torosa longissima* of P. Browne, Hist. Jam. 1756: 246, *pro parte* [excl. Plukenet, 1696: tab. 327, fig. 6; and in agreement with Eichler, 1865: 270 and Fawcett & Rendle 1914a:143,

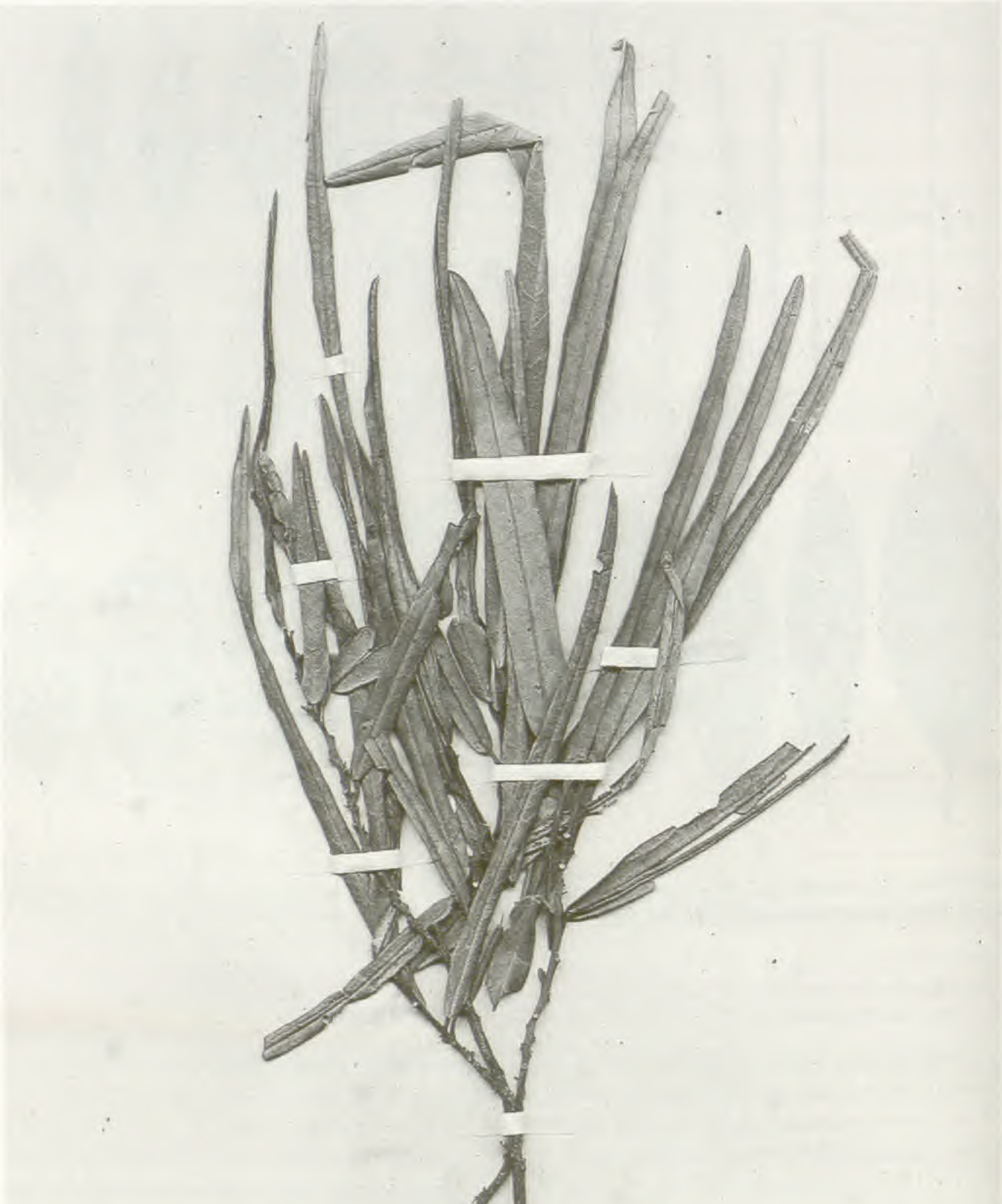
Jamaica : Swartz.
Capparis longifolia Sw.z.

Fig. 4. Holotype of *Quadrella jamaicensis* f. *longifolia* (*Swartz s.n.*, S): a juvenile form of the species, with linear oblong leaf blades.

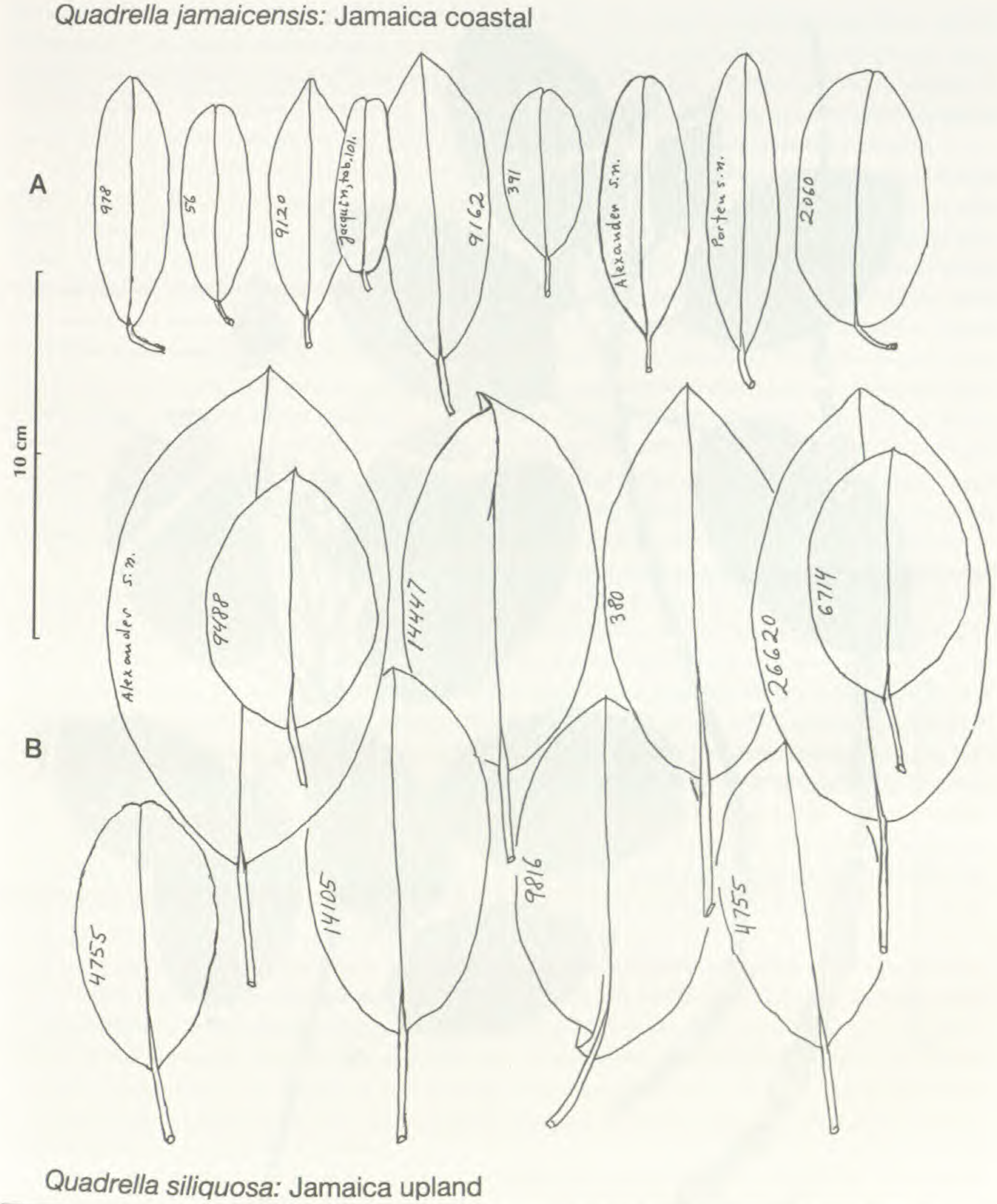
Quadrella jamaicensis: Jamaica coastal
A
978
56
9120
Jacquin, tab. 101.
9162
391
Alexander s.n.
Porter s.n.
2060
10 cm
B
Alexander s.n.
9488
14447
380
26620
6714
4755
14105
9816
4755
Quadrella siliquosa: Jamaica upland

Fig. 5. Leaf blades of *Quadrella* on Jamaica: A. the coastal *Q. jamaicensis*. B. the montane *Q. siliquosa*.

which is *Quadrella jamaicensis* f. *longifolia*, a linear lanceolate stump sprout or juvenile form of *Quadrella jamaicensis*]. For the lectotype of *Capparis siliquosa* L., Al-Shehbaz (1988: 296) selected "(1) siliquosa," Linnaean Herbarium sheet 664.8. Unfortunately, this sheet has two specimens attached to it, neither if which is *Q. siliquosa*. Since Linnaeus, in his original description of *C. siliquosa* (1759), cited Browne's (1756: 246, op. cit.) and then later (Sp. Pl. ed. 2, 1762; ed. 3, 1764) added "Planta forte" and also its resemblance to the preceding *C. cynophallophora* and "Habitat in Jamaica" (all four of these items aplicable only to *C. siliquosa*),

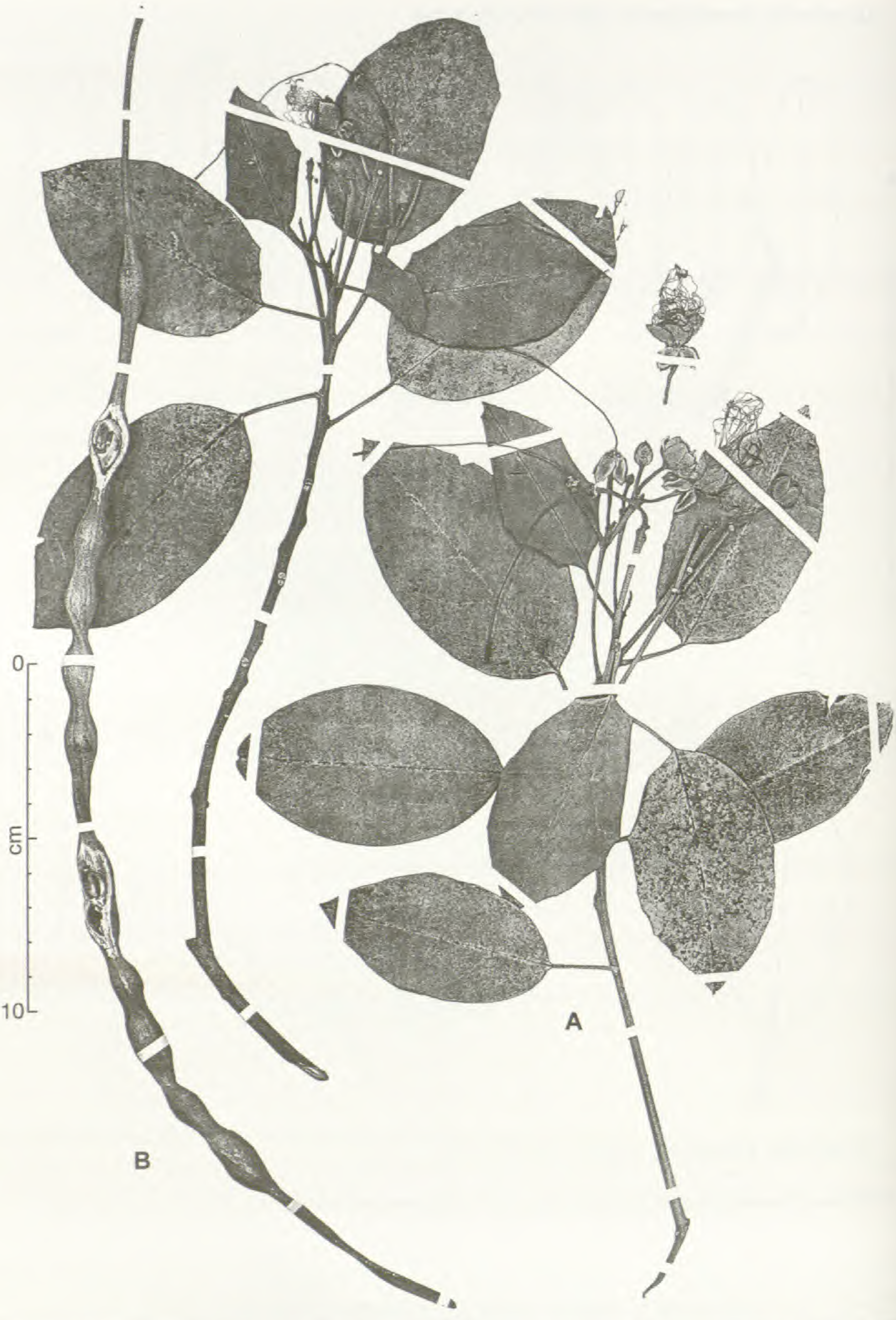

Fig. 6. Lectotype of *Quadrella siliquosa* (*Harris 9488*, BM), a Jamaican endemic: **A.** Flowering branch with 2–4 cm long petioles, 4–7 cm long gynophores and small ovaries. **B.** Mature silique.

we must reject Al-Shehbaz' choice of LINN-664.8. In this mixed collection, the right-hand specimen, labeled "(1) siliquosa," is a typical broadly elliptic, acuminate to acute-leaved *Q. cynophallophora* s.s. (relatively short-petioled, thus not to be confused with the longer petioled *Q. siliquosa*). The left-hand specimen, labeled "2. cynophallophora," is a typical *Q. jamaicensis* with emarginate, notched leaves. We have therefore chosen as a neotype *Harris 9488*, cited above (Fig. 6), about which there can be no argument as to its identity.

One of the pleasurable surprises of this revision was the rediscovery of the taxon now named *Quadrella siliquosa* (L.) Iltis & Cornejo (encompassing *Capparis torulosa* Sw., its ancient synonym). This is a broadly elliptic-leaved mesophytic tree, endemic to the montane woodlands and savannas of Jamaica, apparently closely related to *Quadrella cynophallophora* s.s. All the lowland, mostly coastal, plants in Jamaica belong to *Q. jamaicensis*, a shrub or small tree with uniformly small, hard, shiny, oblong to oblong-elliptic, most often emarginate leaves (Figs. 2, 5A), widespread from Florida to Cuba and occasionally Hispaniola, where it overlaps and intergrades with the more easterly *Q. cynophallophora*. The name *Quadrella siliquosa* must now be restricted to the large shrubs to trees of the Jamaican uplands, with much larger and thinner, more broadly elliptic leaves and almost rounded to broadly acute or abruptly short acuminate apices (Figs. 5B, 6), leaf size and shape presumably all adaptations to the cooler, moister, and shadier conditions of their upland, woodland habitats, as are their longer (2–4 cm) petioles. Although some specimens from the eastern range of *Q. cynophallophora* may have broad leaves, these tend to be more ovate or obovate-elliptic and are borne on shorter petioles (Figs. 2, 3), while those of *Q. siliquosa* are always symmetrically elliptic (Figs. 5B, 6).

The rediscovery of the name *siliquosa* was slow in coming. A review of many photocopies and a few old specimens of these upland plants in the Wisconsin Herbarium pointed to their frequent identification with the name *Capparis torulosa* by botanists of the early nineteenth century. This name, in turn, alerted us to the rather infrequent, strongly torulose siliquiform capsules with more distantly spaced seeds, which, in turn, separated from each other by conspicuous constrictions, helped explain Swartz's (1788) choice of his very apt epithet. Swartz's reference then led us to Browne's (1756) *Breynia 2*, a Jamaican tree different from the shrubby coastal *Breynia 1* (=*Q. jamaicensis*), which in turn led us to the Linnaean *Capparis siliquosa*, also based on the same polynomial description. Swartz (1788: 81) and Browne (1756: 246) emphasized the very long ("longissima"), torulose ["torose"] fruits. Finally, DeCandolle's (1824: 252) statement "in fruticetis montosis Jamaiceae..." clinched the identification of *Q. siliquosa* as the correct name, even though the immediate continuation of Candolle's sentence, "...et Barbados...," pointed to an easy misidentification with some of the broad-leaved and more lanceolate-elliptic collections of *Q. cynophallophora* from that most easterly island, where apparently that species is cultivated extensively.

For the past hundred and fifty years, however, all authors, from Grisebach (1864), Eichler (in Martius, 1865: 270 [both under *C. jamaicensis*]), Fawcett & Rendle (1914a: 143; 1914b: 231–232) to Al-Shehbaz (1988: 296) and Rankin & Greuter (2004), reduced both *Q. siliquosa* and *C. torulosa* to synonyms of *Q. cynophallophora* without further comment, even though on all bio-geo-ecological and morphological grounds the species are amply distinct. Only C.D. Adams, in his *Flowering Plants of Jamaica* (1972: 305–306), clearly notes both the ecological and morphological differences between *Quadrella jamaicensis* and *Q. siliquosa* (both under *C. cynophallophora* s.l., as applied to Jamaica).

Habitat and Distribution.—Jamaica, in upland woodland forests and often on limestone, from 500 to 2300 feet.

Phenology.—Flowering from (January) June to September, and fruiting from September to July.

Vernacular name.—JAMAICA: Zebra wood (*Wright s.n.*, S).

In recent years, *Quadrella siliquosa* has rarely been collected and we are afraid, considering the human population explosion in Jamaica, and the dramatic local destruction of forests, that this interesting endemic species is slowly drifting into extinction. As handsome and bushy-leaved as that tree is reported to be, it surely deserves protection, if nothing else at least if need be by cultivation, or better still in a nature preserve.

Specimens examined: **JAMAICA. Parish not specified:** 1850, *R. Alexander s.n.* (K, WIS photocopy); 1857, *Marsh 247* (K); 1858, *Marsh 41* (K); *Marsh 1528* (GOET, K); *J. Hart s.n.* (NY); *Dr. Wright s.n.* (K, S); *Swartz s.n.* (M); Lititz savanna, *W. Harris 11780* (BM, CAS, GH, K, MO, NY, US); Bath, *Wilson 380* (GH, K); between Ocho Rios & Roaring R., *A. Prior s.n.* (K); at Constant Spring, 1895, *W. Harris 5718* (S

0510026), E. *Campbell 5718* (BM, C, NY); Troy to Oxford, *N. Britton 674* (NY, US, WIS); Postdam woodland, Santa Cruz, *W. Harris 9816* (BM, C, K, NY, US); Robertsfield, *W. Harris 7713* (A, BM, GH, K, US). **Manchester Parish:** Marshalls Pen, 2.25 mi NW Mandeville, *G. Proctor 26620* (IJ, WIS [fragm.]); 1.6 mi NW of Rectory, Mile Gully, *L. Landrum 4755* (WIS). **St. Elizabeth Parish:** between mileposts 4 & 5, Redgate to Ipswich road, *G. Proctor 36828* (IJ); wooded limestone hill 1.5 mi N of shooters hill, *R. Howard & G. Proctor 14105* (A, GH, IJ); Kaiser mine area S of Gutters, forested limestone hills near New buildings, *R. Howard & G. Proctor 13846* (A, GH, IJ); Kaiser mine area at Comfort, on limestone hill, *R. Howard & G. Proctor 14447* (A, BM, IJ). **St. Ann Parish:** Mason River district, ca. 3 mi NW Kellits P.O., *G. Proctor 26473* (GH, IJ, NY, U); near road thru limestone hills betw. Cedar Valley & Ballintoy, *R. Anderson & D. Sternberg 3070* (GH); Reynolds mine area near Lydford P.O., *R. Howard & G. Proctor 14019* (A, GH, IJ, NY, US, WIS).

4. Quadrella gonaievensis (Helwig) Hutchinson, Gen. Fl. Pl. 2: 308. 1967. (**Fig. 8**). Basionym: *Capparis gonaïvensis* Helwig, Ark. Bot. 22A:10. 1929. Type: HAITI: "Peninsula sept.-occidentalis ad viam inter Les Gonaïves et Hatte-Rocher prope mangrove communis," *E. Ekman 8483* (holotype: B!, B fragm. & photo at WIS; isotypes: GH!, IJ!, US!).

Shrub or treelet to 7 m tall, abundantly branched, densely ferrugineous-lepidote throughout. Leaf blades evergreen, chartaceous, dark green, usually minutely dark punctate, lustrous and glabrous above, lepidote beneath, elliptic to lanceolate, 3–7 × 1.2–3 cm, acuminate at apex, cuneate at base; petioles 1–1.5 cm; juvenile leaves linear to linear-lanceolate, 11–18 × 0.4 cm, with petioles 0.5–1.3 cm. Inflorescences corymbose; small delicate flowers on complanate peduncles 0.5–2.5 cm, and pedicels 0.6–1.2 cm. Petals broadly ovate, 6–7 × 5–6 mm, obtuse at apex, white; sepals ovate-elliptic, ca. 5 × 3 mm; nectar scales flat, one each projecting from inner sepal bases, ca. 1–1.5 mm; stamens 15 to 20, filaments 0.9–1.8 cm, densely lepidote-radiate or lepidote-stellate at base, the anthers 1–2 mm; gynophores 0.7–2 cm, ovaries oblong, ca. 3 mm. Fruits small siliquiform capsules, 2–6 × 0.4–0.5 cm, subtorulose, with red pulp, on short gynophores 8–16 mm; seeds 5–7 × 4–5 mm.

Habitat and Distribution.—A rare, highly localized but scattered endemic of Haiti and adjacent western parts of the Dominican Republic (Fig. 8), growing near mangrove communities and along rivers, characterized by its delicate small flowers with distinctive lepidote-radiate or lepidote-stellate trichomes at the base of the filaments. This species has usually been overlooked, or listed in synonymy under *Q. cynophallophora* (Urban 1920–21: 239; Al-Shehbaz 1988; Rankin & Greuter 2004).

Phenology.—Flowering from May to November; fruiting in April, September.

Specimens examined: **HAITI.** Gonaïves, Marchand, *W. Buch 434* (B, IJ); ad Les Poteaux in collibus, *E. Ekman 9059* (IJ, LL-TEX, WIS [fragm.], US); au Trou, *E. Ekman 9882* (B, IJ); Iles Gonaïvensis, 1854 or 1855, *N. Prac s.n.* (P [2]). **SANTO DOMINGO. Barahona:** Am Yaqui Fluss, *Pater Fuertes 111* (LD, P, U, US, WIS, Z). **Monte Cristi:** Valle del Cibao, betw. Navarrete & Villa Vasquez, *E. Ekman 13120* (A, B, C, GH, LL-TEX, US). **Sine loc.:** 1853, *M. Schombourg 25* (K, P).

5. Quadrella quintanarooensis Iltis & Cornejo, sp. nov. (**Figs. 7, 9A, B**). Type: MEXICO. Quintana Roo: Xcaret, a 5 km al S de Playa del Carmen, selva mediana, 15 Sep 1982 (fr), *E. Cabrera & H. de Cabrera 3495* (holotype: MEXU, MEXU fragm. at WIS; isotypes: CAS, MO).

Species affinis *Quadrella cynophallophora* (L.) Hutchinson, a qua differt gynophoris extrematis minoribus vel absens, 0–5 mm longis, filamentis minoribus 6–15 mm longis, endemicus ex Isla de Cozumel et costa affinis ad Quintana Roo, Mexico.

Trees or shrubs 2–8 m tall, peltate-lepidote throughout. Leaf blades somewhat stiff, coriaceous, evergreen, narrowly elliptic, oblanceolate or obovate to broadly-elliptic or rarely ovate, 6–13 × (2.5–)3–6.5 cm, apex narrowly acute to long acuminate, at base cuneate to broadly truncate, with flat margins (when dry), usually lustrous above, densely covered beneath with colorless, peltate lepidote hairs with a light brown center, the wing several to many times slashed, sometimes the under-surface peppered with scattered darker orange hairs, secondary veins inconspicuous; petioles 0.7–2.3 cm, canaliculate. Flowers solitary or short axillary corymbose racemes at the ends of branchlets, the flattened peduncles 0.5–5 cm, bearing 1 to 6 flowers each; floral bracts soon caducous; flower buds spherical to ovate, longitudinally 4-ribbed, 6–9 mm; pedicels 0.5–2.2 cm. Calyx quadrangular, sepals ovate, 7–9 × 4–5 mm, reflexed at anthesis, yellowish tomentose within; nectar scales triangular, 1.5–2 × 2 mm, projecting from receptacle and the inner sepal bases; petals 8–9 × ca. 6 mm, stamens number unknown (ca. 30), with filaments 0.6–1.5 cm, and anthers 3–4 mm; androgynophores ca. 1 mm, the remarkably short, reduced gynophores only 0.5–5 mm or even absent; ovaries linear-cylindric, 4–6.5 mm, brown and densely peltate-lepidote, the stigmas truncate. Fruits

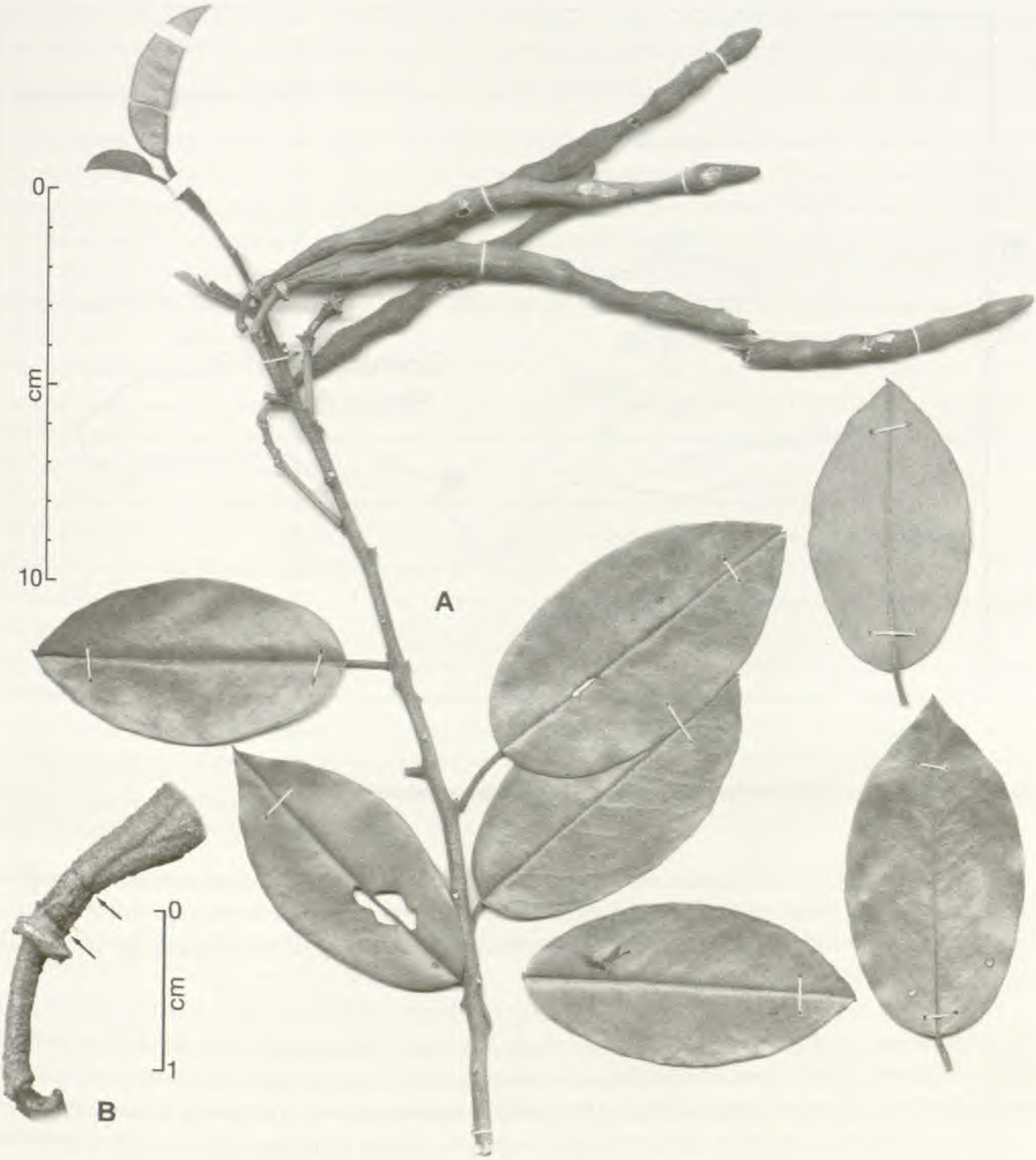

Fig. 7. Holotype of *Quadrella quintanarooensis* (*Cabrera 3495*, MEXU): A. Fruiting branch. B. Close-up of the characteristic, highly reduced gynophore in fruit.

linear-cylindric siliquiform capsules, 6–32 × 0.5–0.9 cm, brown, densely lepidote without, bright orange within, ± torulose, on very short and thick, 1–5 mm gynophores and 0.5–2.2 cm pedicels; seeds 5–8 × 4–6 mm, covered by an orange aril, the embryo green.

Despite the hundreds of thousands of tourists that now visit Cozumel Island and Tumul each year, it was not until the 1980s, when the tourist industry opened up the region, that Edgar Cabrera and associates (MEXU), discovered this interesting local endemic, which, apparently an offshoot of *C. cynophallophora* s.s. and generally so identified, differs from it by the highly reduced to essentially absent gynophores in flowers or fruits (Fig. 7B).

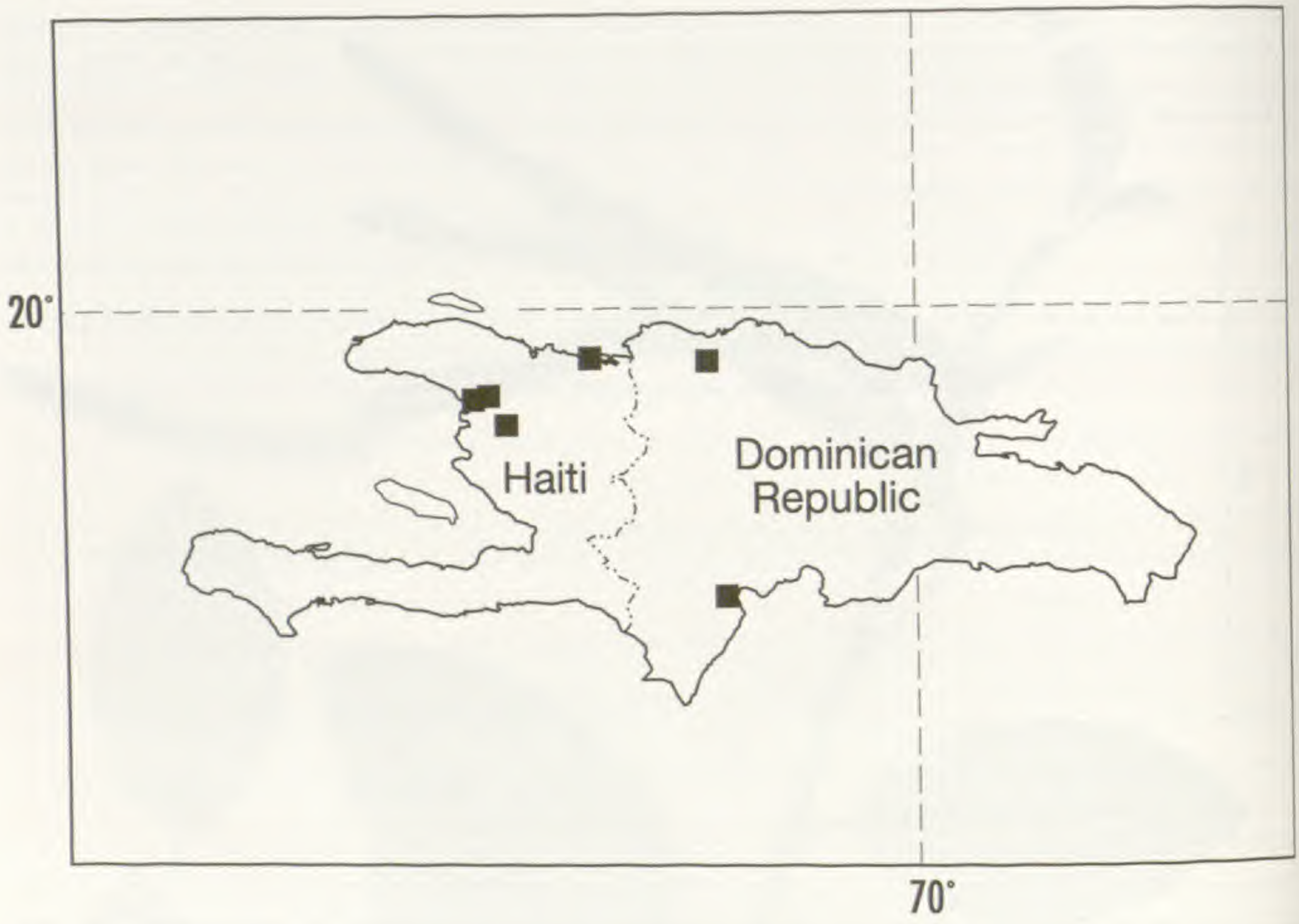

Fig. 8. Map of scattered geographic distribution of *Quadrella gonaievensis*, a rare endemic of Hispaniola.

In their variable size, acuminate outline, and the occasional peppered appearance of the peltate pubescence on their underside, the leaves of *Quadrella quintanarooensis* are similar to the northern collections of the nearby but allopatric *Q. isthmensis* subsp. *mexicana*, which may well be due to some past introgression that may have influenced its morphology.

By its very short or absent gynophore, this species resembles somewhat the distinctive, silvery peltate *Quadrella odoratissima* (Jacq.) Hutchinson (one of only three species of *Quadrella* sect. *Quadrella* not included in the *Q. cynophallophora* complex) distributed from southern Mexico to northern Colombia and Venezuela, the Dutch West Indies and Trinidad. However, *Quadrella quintanarooensis* differs from *Q. odoratissima* by its longer, quadrangular, not spherical calyx, longer rusty brown fruits, wider leaf blades with flat not revolute margins when dry, and light brown pubescence.

Habitat and Distribution.—In open, dry, highly seasonal tropical forests and woodlands (selva baja mediana, selva mediana subperennifolia [Rzedowski 1978]), often with *Pseudophoenix sargentii* H. Wendland ex Sargent (Palmae), *Manilkara* Adanson (Sapotaceae), *Coccoloba* P. Browne (Polygonaceae), *Beaucarnea* Lemaire (Agavaceae) and other xerophytes, on or near beaches at sea level to 50 m on Cozumel Island and the adjoining mainland of Quintana Roo, apparently not uncommon locally but restricted to this very small area on the northeastern coast of the Yucatán Peninsula of Mexico (Fig 9).

Phenology.—Flowering from April to July and fruiting from July through October.

Paratypes: **MEXICO. Quintana Roo:** Mun. Benito Juárez, Puerto Morelos, Jardín Botánico CIQRO, *H. Uitzil, M. Canche & S. Escalante 107* (MEXU [2]). Xcaret, 5 km S desviación a Playa del Carmen, *E. Cabrera & H. de Cabrera 9267* (MEXU, MO); 5 km S Akumal, carr. Cancún-Tulum, *E. Cabrera & H. de Cabrera 5530* (MEXU, MO); 6 km S Akumal, carr. Cancún-Tulum, *E. Cabrera & H. de Cabrera 6501* (MEXU, MO); 8 km S Akumal, carr. Cancún-Tulum, *E. Cabrera & H. de Cabrera 4739* (MEXU, MO); 10 km S Akumal, *E. Cabrera & H. de Cabrera 3610* (MEXU, MO). Mun. Solidaridad, X'cacel-X'cacelito, ca. 13 km N Tulum carr. 307 Chetumal-Puerto-Juárez, *C. Gallardo 2230* (MEXU); Isla Cozumel, 8 km S El Cedral, camino a Punta Celarain, *E. Cabrera & H. de Cabrera 6741* (MEXU, MO). Mun. Cozumel, 1 km N Xel-ha, *E. Cabrera & H. de Cabrera 7170* (MEXU, MO); 3 km N Xelha, *O. Téllez, E. Cabrera & L. Rico 3570* (BM, MEXU, MO, NY); 12 km S de la ciudad de Cozumel, sobre la costera que va hacia la punta sur, *E. Cabrera & H. de Cabrera 6361* (MEXU, MO).

6. Quadrella isthmensis (Eichler) Hutchinson, Gen. Fl. Pl. 2: 308. 1967.

Shrubs to slender trees 3–10 m tall, rusty brown peltate-lepidote throughout, the branchlet tips and peduncles flattened. Leaves thinly coriaceous, ± evergreen, dark green and glabrous above, densely covered with light golden or silvery (often peppered, with golden or rusty brown) peltate-lepidote hairs beneath; leaf blades conduplicate when young, elliptic, oblong elliptic to oblanceolate, sometimes rather abruptly acuminate into a sharp drip tip apex, usually cuneate to widely rounded at base, (excluding the linear, juvenile or stump sprout leaves) (6–)8–21(–26) × (2–)4–8.5 cm, with strongly impressed midrib on upper surface, secondary nerves rather inconspicuous on both sides; petioles (0.5–)1–4 cm, canaliculate. Inflorescences leafy corymbs, with 1 to 5 peduncles 0.5–10 cm, borne leaf axils at branch apices, each corymb 1 to 7-(to 13) flowered, linear bracts 2–6 mm, usually soon caducous; pedicels stout, usually ± flattened, 0.5–4.5 cm, bright rusty brown, lepidote; sepals valvate, before anthesis totally enclosing petals to form an ovoid to lanceolate, pointed, ± longitudinally ribbed bud, sepals after anthesis reflexed, ovate to lanceolate, (9–)10–18 × 5–8 mm, densely rusty lepidote without, tomentose to tomentulose within; nectar scales triangulat to deltoid and flat, one each projecting from inner sepal bases; petals divergent at anthesis, creamy white, soon fading (as do the stamens) to a purplish violet, elliptic-obovate, (9–)10–20 × 6–10 mm, glabrous within; stamens ca. 30 to 60, 20–70 mm, densely white pilose at base, anthers 3–5 mm; gynophore (10–)15–80 mm, glabrous, on an androgynophore 1–2 mm, ovaries linear cylindric, 6.5–10 mm, densely peltate-lepidote, stigma truncate. Fruits linear cylindric capsules, (6–)10–60 × 0.4–1.2 cm, dark rusty brown lepidote throughout, ± torulose, ± irregularly rupturing along (usually one) suture, the valves turning out to expose their pulpy bright orange to scarlet inner wall and embedded in it the bright orange to red arillate seeds, these often dangling by a thin funicular thread; gynophores 15–80 mm, glabrous, clearly demarcated from the fruit valve, receptacular disks in fruits 5–10 mm diam.; pedicels 1.5–4 cm, lepidote; seeds (3 to) 6 to 40, oblong, 6–8 mm, with bright orange aril, the embryo oblong, green throughout.

6a. Quadrella isthmensis subsp. **isthmensis** (Eichler) Hutchinson, Gen. Fl. Pl. 2:308. 1967. (**Figs. 9C, 11**). Basionym: *Capparis isthmensis* Eichler in Martius, Fl. Bras. 13:269. 1865. Type: COSTA RICA: "Habitat ad Costa Rica et Veraguas Americae Centralis," without date, *C. Hoffmann & Warszewicz 217* (lectotype, designated here B, B fragm. at M, WIS).

Capparis chiriquensis Woodson, Ann. Miss. Bot. Gard. 35:92, fig. 49. 1948. Type: PANAMA. Chiriquí: vic. Puerto Armuelles, 0–75 m, 28–31 Jul. 1940, *R. Woodson & R. Schery 846* (holotype: MO; isotypes: GH, US, US photo at WIS).

Leaf blades (6–)8–21(–26) × (2.5–)4–8.5 cm, matte above (when dry), on petioles to 4 cm. Inflorescence peduncle to 10 cm; floral bracts linear, 3–6 mm, usually soon deciduous in very young buds; flower buds ovate (in Panama) to mostly lanceolate (in Costa Rica), often with sharply angled longitudinal sutures; sepals ascendent to reflexed; petals ovate to elliptic, 12–18 × 7–10 mm; stamens 4–7 cm, gynophores 4–8 cm; fruits often very long, 10 to 60 cm, light to copper-brown, with elongate gynophores 4–8 cm, and pedicels (1.3–)2–4.5 cm; seeds 7–10 × 4.5–7 mm.

The lectotype of *Capparis isthmensis* is designated here because in the protologue, Eichler only cited "Habitat ad Costa Rica et Veraguas Americae Centralis: *C. Hoffmann et Warszewicz*," but the number of collection was not specified.

Typical *Quadrella isthmensis* is characterized by the large, elliptic, acuminate leaves with drip tips and often relatively long capsules, as well as by a silvery, pronouncedly bronze peppered, peltate-lepidote pubescence, especially on the underside of the leaves. The ovaries and petals are longer than those of *Quadrella cyanophallophora* or *Q. siliquosa*; and the gynophores in flower and fruit are longer than those of the other subspecies in *Quadrella isthmensis*.

Quadrella isthmensis subsp. *isthmensis* presents no special taxonomic problems, except for occasional plants from the arid southern beaches and islands off Panama's Pacific coast, which tend to have smaller, thicker leaves, this apparently a response to local aridity. While these plants resemble *Quadrella cynophal-*

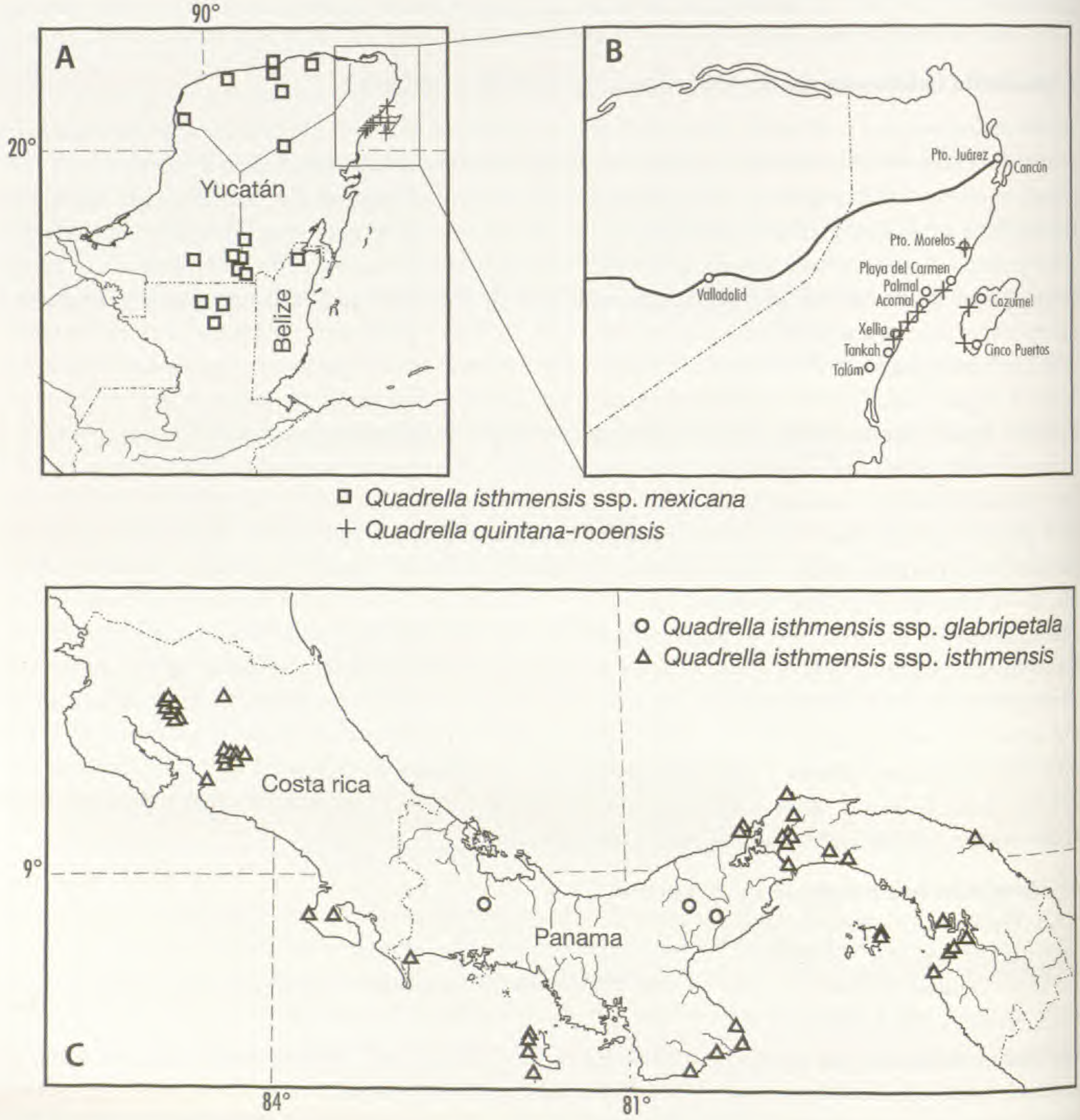
90°
A
20°
Yucatán
Belize
B
Pto. Juárez
Cancún
Pto. Morelos
Playa del Carmen
Palmal
Acomal
Valladolid
Cozumel
Xellia
Tankah
Tulúm
Cinco Puertos
□ Quadrella isthmensis ssp. mexicana
+ Quadrella quintana-rooensis
○ Quadrella isthmensis ssp. glabripetala
△ Quadrella isthmensis ssp. isthmensis
Costa rica
9°
Panama
C
84°
81°

Fig. 9. Map of the members of the *Quadrella cynophallophora* complex on the Yucatan Peninsula of Mexico: A. *Q. isthmensis* subps. *mexicana* (hollow squares) and *Q. quintanarooensis* (crosses). B. Map showing the localities on Cozumel Island and adjoining mainland in Quintana-Roo where *Q. quintanarooensis* (crosses) has been collected. C. Map of the distribution of *Quadrella isthmensis* subsp. *isthmensis* (hollow triangles) in Panama and Costa Rica, and *Quadrella isthmensis* subsp. *glabripetala* (hollow dots) in Panama only.

lophora, that species does not occur on the Meso- or South American mainland and is easy to tell apart by its narrower floral receptacle and the smaller ovaries, petals and leaves.

The seeds of *Quadrella isthmensis* are facultatively viviparous, sometimes even germinating within the fruit while yet borne on the plant (*Castroviejo et al. 7186*). This is an interesting observation considering the short seed viability, well known for a long time in two unrelated New World Capparid genera with green embryos linked to thin, flexible and slippery seedcoats (testas), namely, *Cynophalla* and *Quadrella* (subg. *Quadrella* and subg. *Breyniastrum*, but not in its subg. *Intutis*, with its hard, brittle testas linked to white or creamy embryos).

The first author may assume that their seed dispersing agents, be they bats, rats, birds or lizards (we really do not know!), take a seed and, after swallowing the desired aril together with the thin testa (which, with a little manipulation easily slip off the distasteful acrid, now naked embryo), spits out the embryo, which then could start to photosynthesize and grow into a seedling soon after it hits the ground (Iltis, unpubl.).

A chance reading of the "*Capparis*" treatment in Linnaeus' *Pflanzensystem* (1779), the rare 16-volume German translation from the Latin 13th edition of *Systema Naturae* (1764) (Anonymous 1933), has this to say about the seed germination of "*Capparis cynophallophora L.*" (by which the author meant not the densely peltate-pubescent *Quadrella cynophallophora*, but the glabrous *Cynophalla flexuosa* (L.) J. Presl (= *Capparis flexuosa* (L.) L.), [judging from its thick, stiff, smooth leaves with "glandulis axillaribus LINN. Syst. Veg. p. 405 Sp. pl. 721 [should be 722!], …which on both surfaces are completely smooth…," reflecting the horrible nomenclatorial confusion dating back to old Linnaeus himself between two of the most widespread and common Neotropical species that are also the two most common Capparids grown by the British and Dutch aristocrats, a confusion lasting well into the 20th Century (e.g., Pax and Hoffmann 1936:178):

> "The fruits, as soon as they are ripe, split into two halves, which immediately twist back to let the white seeds, which are embedded in a soft scarlet pulp, fall out…. These seeds start to germinate almost immediately, and that is why one cannot send them to Europe [from overseas] any more than any of the other American capers, all of which quickly dry out and spoil."

Habitat & Distribution.—This, the typical subspecies is found in Costa Rica, from sea level (in Corcovado National Park, Osa Peninsula) to 900 m (in the Cordillera de Tilarán, Río San Luis valley below Monteverde Cloud Forest Reserve), generally on the Pacific slope, in wet or moist tropical forests, and east to Panama, in drier habitats in the Pacific lowlands. In Panama, this subspecies is often found at or near sea level on beaches or behind mangroves, apparently not overlapping the range of the montane *Quadrella isthmensis* subsp. *glabripetala* in the Cordillera Central. Surprisingly, *Q. isthmensis* is not known to occur in Nicaragua even though, under the name of *Capparis cynophallophora*, it was optimistically listed as a species to be expected (Iltis 2001: 570).

Phenology.—Flowering from January through April (September to October), fruiting from June to December.

Vernacular name.—COSTA RICA. camarón blanco (white shrimp), (*J. León* 953, F; Zamora 1989).

Specimens examined. **COSTA RICA. Puntarenas:** forest near Palmar Norte, *P. Allen 6639* (F); Res. Biol. Monteverde, Cordillera de Tilarán, *J. Morales 2436* (INB, WIS); SW & below Res. Biol. del Bosque nuboso de Monteverde, *H.H. Iltis et al. 30337, 30341* (WIS); Monteverde, 10 km SO, on road to Inter American hwy, *W. Haber & W. Zuchowski 9933* (INB, MO, WIS); 9 km W Monteverde on road to Inter American hwy, *W. Haber & W. Zuchowski 9248* (CAS, CR, INB [2], MO, VDB, WIS). *W. Haber & W. Zuchowski 9761* (INB, MO, WIS); 4 km W of Monteverde, Cuencas del Lagarto y Guacimal, *W. Haber & N. Obando 12128* (INB); trail from Playa Manuel Antonio to Puerto Escondido, *M. Grayum & P. Sleeper 5921* (MO, WIS); Miramar, Cerro Zapotal, Quebrada Seca, *L. Gómez, et al.* 23994 (MO, WIS); Carara Reserve, *M. Grayum & R. Warner 5707* (MO), sendero Quebrada Bonita a Bijagual, sitio Lomas Pizote, *R. Zúñiga & Q. Jiménez 14* (MO, WIS); Cantón Golfito Jiménez, Río Piro y Quebrada Coyunda, *A. Chacón 1039* (MO [2], WIS [2]); Alto Carbonera, cerro Osa, cabeceras de Quebrada Sombrero, *G. Herrera 4344* (INB, MO, WIS); Osa, 3 km N de Playa Piro, Puerto Jiménez, *Q. Jiménez et al.* 659 (MO); Osa Península, Corcovado Nat. Park, Sirena, *R. Liesner 2976* (MO, WIS), *P. Delprete 5152* (TEX), *R. Liesner 2825* (MO); entre Senderos a Río Claro y a Los Patos, *G. Fonseca 56* (INB, MO); *R. Aguilar 2477* (CR, INB, WIS); *O. Téllez 4247* (MEXU, MO); *A. Chacón 86-05* (WIS); *S. Knapp 2186* (MEXU, MO, WIS); *W. Alverson 1837* (WIS); *G. Maass 90* (INB, WIS); *A. Gentry & OTS class 48484* (MO, WIS); *C. Kernan 61* (MO); *J. Saborio 83* (MO, WIS); *G. Fonseca 14* (INB, MO); Res. For. Golfo Dulce, Rincón, *L. Angulo 498* (INB). **San Jose:** Z. P. La Cangreja, Cerros de Puriscal, Santa Rosa de Puriscal, *J. Morales & Q. Jiménez 3317* (INB, MO); Pérez Zeledon, Tinamaste, Finca de Los Suizos, *A. Estrada et al. 1584* (MEXU); Río Naranja, versant Pacifique, *A. Tonduz 7656* (BR, WIS fragm.). **Guanacaste:** Hojancha de Nicoya, *J. León 953* (F); Zona Protectora Nosara, Res. For. Monte Alto, *L. González & F. Hidalgo 2917* (INB); *J. Morales 8711* (INB); Cerro San José, near H. Granadilla, *C. Dodge & W. Thomas 6459* (F, MO); 5.4 mi. W of Tilaran on road to Laguna de Arenal, *D. Stone 2168* (DUKE); *J. Walker 405* (GH); vic. of Tilarán, *P. Standley & J. Valerio 45705* (A); Zona Protectora Abangares, *U. Chavarría & F. Alvarado 1732* (INB, MEXU). **Alajuela:** San Ramón, Finca San Gerardo, *A. Carvajal 117* (MEXU, MO [2], WIS); near Atenas, in monte Aguacate, *Ørsted 3168* (C); San Miguel de San Ramón, orillas del Río Barranca, *A. Brenes 21952* (F, NY); San Pedro de San Ramón, *A. Brenes 6686* (NY); Santiago, camino de San Francisco de San Ramón, *A. Brenes 6668* (F, NY); Santiago de San Ramón, *A. Brenes 6633* (F, NY). **PANAMA. Veraguas:** S shore of Ensenada Santa Cruz, N tip of Coiba Island, *R. Foster 1621* (DUKE, F, MO, PMA), *R. Foster 1644* (DUKE, F, MO, PMA); Isla Coiba, camp. Manila, *S. Castroviejo & M. Velayos 8231* (MA, MO); Río Manila, *B. Aráuz et al. 400* (MA, MO); Boca Grande, *C. Galdames et al. 3653* (MA); Playa de la Salina, borde de la playa, *S. Castroviejo et al. 7186* (MA, MEXU); Par. Nac. Coiba, Isla Jicarón, *C. Galdames, et al. 4000* (BM, MA, MO). **Canal Zone:** Madden Dam, *J. Ebinger 867* (F, PMA); Boy Scout Rd., Madden Dam area, *D. Porter et al. 4054* (MO, WIS); *J. Dwyer & Lallathin 8830* (F, MO); *T. Elias 7509, 7510* (MO); Fort Clayton, 1 mi. bey. Madden Dam Bridge, *M. Correa & R. Dressler 354* (DUKE, MO, PMA, SCZ); vic. Salamanca Hydro. Stat., Rio Pequeni, *R. Woodson et al. 1555* (A, MO, NA, NY, US); W of Limon Bay, Gatun Locks and

Gatun Lake, *I. Johnston 1823* (A, MO, MEXU, NY); Victoria fill, near Miraflores Locks, *P. Allen 1748* (MO, US); *P. Allen 1760* (MO, NY, US); trail along Rio Petitpie, near road to Fort Sherman, *S. Mori & J. Kallunki 5011* (MO, US, WIS [3]). **Los Santos:** Punta Mala, *T. Croat 9757* (DUKE, MO, SCZ, WIS); *E. Tyson 2727* (SCZ); Isla de Cañas, *L. Carrasquilla 3011* (MO, PMA); playa de Cambutal, entre Punta Blanca y Punta Morro de Puercos, M. *Correa et al. 4390* (PMA). **Comarca de San Blas:** Isla de Pinos, *J. Kirkbride 208* (MO, NY, SCZ). **Darien:** vic. La Palma, *H. Pittier 5504* (B, BM, GH, NY, US); Patiño, on cliff along beach, *H. Pittier 6608* (GH, NY, US); *J. Duke 10533* (MEXU, MO); Rio Cucunati at Puente Quemado, *J. Duke 8813* (MO). **Panama:** swamp betw. El Jagua Hunt. Club on Río Jagua & El Congor Hill, *A. Hunter & P. Allen 480* (BM, BR, MO, WIS fragm.); near archeol. site at Madden Lake, *A. Gentry 5015* (MO, NY, WIS); Chiltepe, *L. Holdridge 6463* (DUKE, PMA), *L. Holdridge 6465* (PMA, WIS); Isla del Espiritu Santo, *J. Duke 10459* (MO); Perlas Islands, *E. Tyson 5569* (DUKE, MO, SCZ); near Punta Garachine, *J. Duke 10486* (WIS). **Colon:** along coastline betw. Garotte and La Guaira, *D'Arcy 9367* (MO).

Subspecies of *Quadrella isthmensis* on Yucatan

The disjunct occurrence of *Quadrella isthmensis* subsp. *mexicana* on the Yucatan Peninsula is problematic, both in its geography, morphology, and relationships. Ranging from tropical seasonally dry, high forests in Guatemala and Belize, where very rare, all the way to the dry forests beaches and edges of mangroves far to the north in Mexico, the plants follow somewhat of a cline, from rather typical but, somewhat smaller leaves from around Lago Peten Itza and elsewhere in Peten Province and in Belize, to smaller, stiffer, more narrowly lanceolate-elliptic leaves in the dry deciduous forests of northern Yucatan (Fig. 9A).

Mexican specimens of *Quadrella isthmensis* subsp. *mexicana* were initially identified as *Capparis cynophallophora*, the leaves of which resemble somewhat the leaves of our Mexican subspecies, were it not that the latter species shares at anthesis the larger ovaries with *Q. isthmensis* and the characteristic bronzed dotted, peppered pubescence on the underside of the leaves. In addition, the closest *Quadrella* populations in Mexico are those of the endemic *Q. quintanarooensis*, and are apparently vegetatively closest to *Q. cynophallophora*. Thus, since we are faced with an isolated, somewhat morphologically differentiated population ca. 1000 km disjunct to the east from the main population of *Quadrella isthmensis* in Costa Rica and Panama, we have decided to name it:

6b. Quadrella isthmensis subsp. **mexicana** Cornejo & Iltis, subsp. nov. (**Figs. 9A, 10**). TYPE: MÉXICO. YUCATÁN: Las Bocas de Silam [Dzilám], May 1916 (fl), *G. Gaumer & sons 23344* (HOLOTYPE: MO; ISOTYPES: BM, F, K, NY, US).

Subspecies affinis *Quadrella isthmensis* subsp. *isthmensis* (Eichler) Hutchinson, a qua differt petiolis minoribus (ad 1.7[–2.3] cm longis), petalis (9–13 mm longis), stamina (2–4[–4.5] cm longis), gynophoris (1–4 cm longis) et fructis (ad 23 cm longis).

Leaf blades 6–15 × 1.5–6 cm, often lustrous above when dry, on petioles to 1.7(–2.3) cm. Inflorescence peduncle 0.7–5.5 cm, floral bracts linear, ca. 2 mm, soon deciduous; flower buds ovate, with softly angled longitudinal sutures; flowers with petals lanceolate to somewhat elliptic, 9–13 × 6–7.5 mm; stamens 2–4[–4.5] cm, gynophores 1–4 cm. Fruits relatively shorter than the typical subspecies, to 23 cm, on usually shorter gynophores, (1–)2–4(–5.5) cm, and pedicels 1–2 cm; seeds 6–8 × 4–5 mm.

Habitat & Distribution.—This new subspecies, one of the successional elements from the mangrove's landward borders in Yucatan (*Lira et al.* 368), ranges inland through selvas medianas subperennifolias south to high forests in Guatemala and adjoining Belize.

Phenology.—Flowering from (February) April through May, fruiting from (June) August through September.

Vernacular name.—MEXICO, YUCATAN: caimito-che (*Enríquez 544*, MEXU).

IUCN.—Because of the numerous collections gathered in recent years, this new subspecies deserves a lower concern, LC.

PARATYPES: **MEXICO. Yucatan:** Progreso, km 10–16 carr. Sierra Papacal a Chuburná Puerto, *G. Campos & P. Simá 2828* (CICY, MEXU); Chichankanab, *G. Gaumer 1910* (B, BM, C, F, GH, MO, NY, US); Port Silam [Dzilám], *G. Gaumer 657* (BM, C, F, GH, K, LE, MO, NY, US), *G. Gaumer 1548* (F), *G. Gaumer 15685* (F, MO, WIS); S de Dzilám de Bravo, *R. Durán & J. Trejo 1626* (MEXU); 3 km S Río Lagartos, *E. Cabrera & H. de Cabrera 4670* (MEXU, WIS) ; Cenotillo, *O. Enríquez 544* (MEXU, US, WIS neg. M4-10 & fragm.); Holpechén, camino blanco entre Kancabchén y Chunchintok, *C. Chan 4025* (MEXU). **Campeche:** vic. Xpujil, crossroads 153 km E of Escárcega on Escárcega-Chetumal hwy, *J. Shepherd 74* (F, MEXU, MICH, XAL, WIS); Mun. Calakmul, 7 km SO Dos Naciones, *E. Martínez, D. Alvarez & B. Sanders 30511-C* (MEXU); camp. costa Maya, 6 km O Narciso Mendoza, *E. Martínez & D. Alvarez 30808* (MEXU); Narciso Mendoza, zona urbana, *D. Alvarez 680* (MEXU); 1.5 km NW Pioneros del Rio, camino a Santa Rosa, *E. Martínez, D. Alvarez & C. Galindo 30661* (MEXU); 40 km

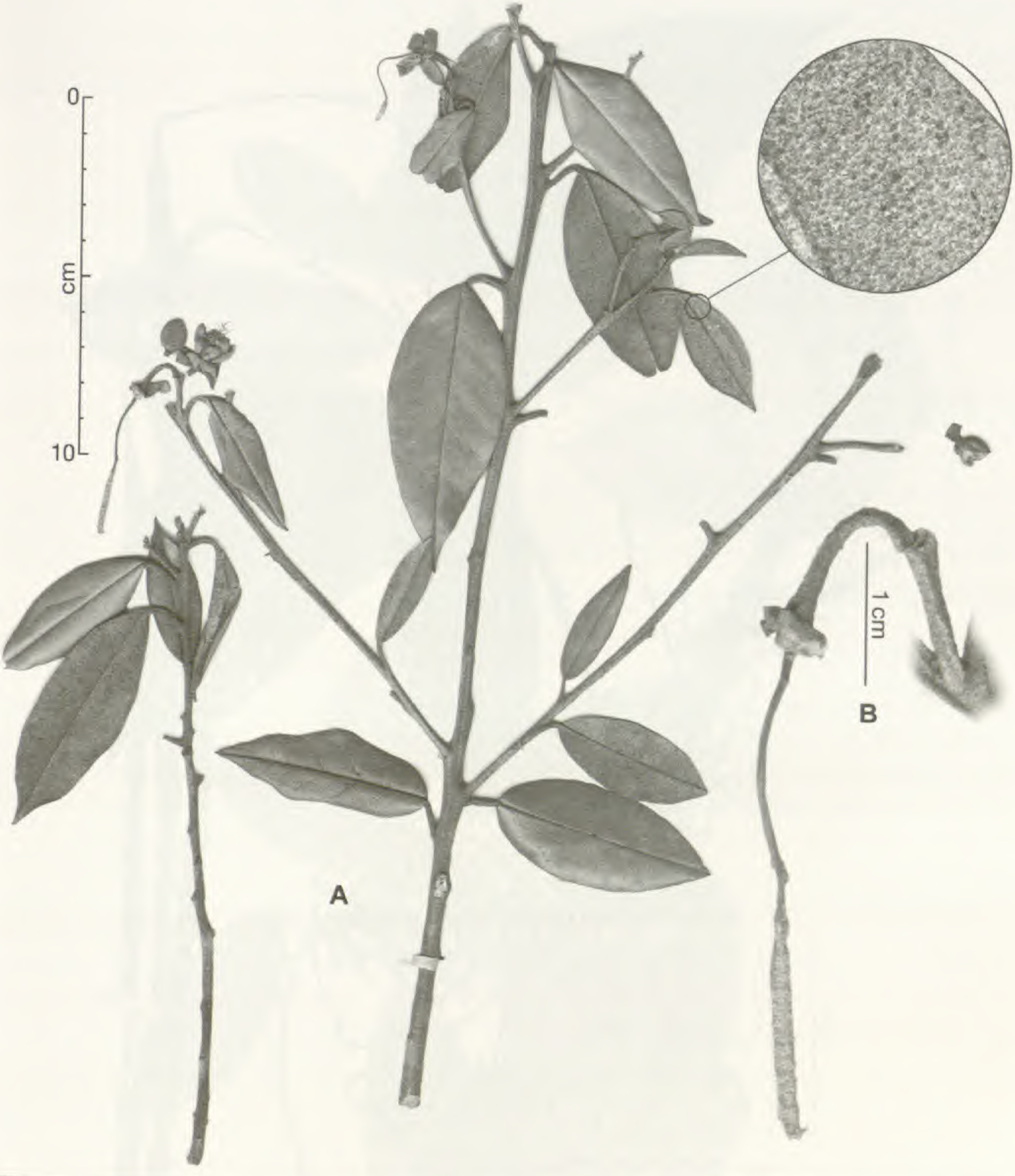

Fig. 10. Paratype specimen of *Quadrella isthmensis* subsp. *mexicana* (*Gaumer 657*, WIS): A. Flowering branches. B. Close-up of a post-anthesal flower in immature fruit, showing a gynophore relatively shorter than in the typical subspecies.

N Núcleo arqueol. Calakmul, *C. Gutiérrez 5336* (MEXU); camino Pomuch a Isla Jaina, Hecelchakán, *R. Lira, J. Flores, E. Góngora & P. Galván 368* (MEXU). **GUATEMALA. Peten:** Lake Peten Itza, betw. San José & El Remate, *E. Contreras 6982* (LL-TEX, MEXU, MO, US); bordering Lake Peten Itza, El Jobo, *E. Contreras 5748* (LL-TEX, US, WIS), *E. Contreras 5749* (LL-TEX); ca. 2 km from San José, *C. Lundell & E. Contreras 20392* (LL-TEX, WIS); 2 mi. SW Carmelita on the Paso trail, *F. Engler 42-274* (F); Uaxactún to San Clemente, *Bartlett 12791* (CAS, US). **BELIZE. Corozal:** Cerros Maya Ruins, Lowry's Bright, *C. Crane 559* (LL-TEX). **Sine loc.:** *A. Castillo 10* (WIS [MAD])

6c. Quadrella isthmensis subsp. **glabripetala** Cornejo & Iltis, subsp. nov. (**Figs. 9C, 12**). Type: PANAMA. Chiriquí: near Fortuna Dam Camp, seasonally dry evergreen forest, 8°43'N 82°14'W, 1200 m, 26 Feb 1985 (fl), *R.J. Hampshire & C. Whitefoord 111* (holotype: MO; isotypes: BM, PMA, WIS).

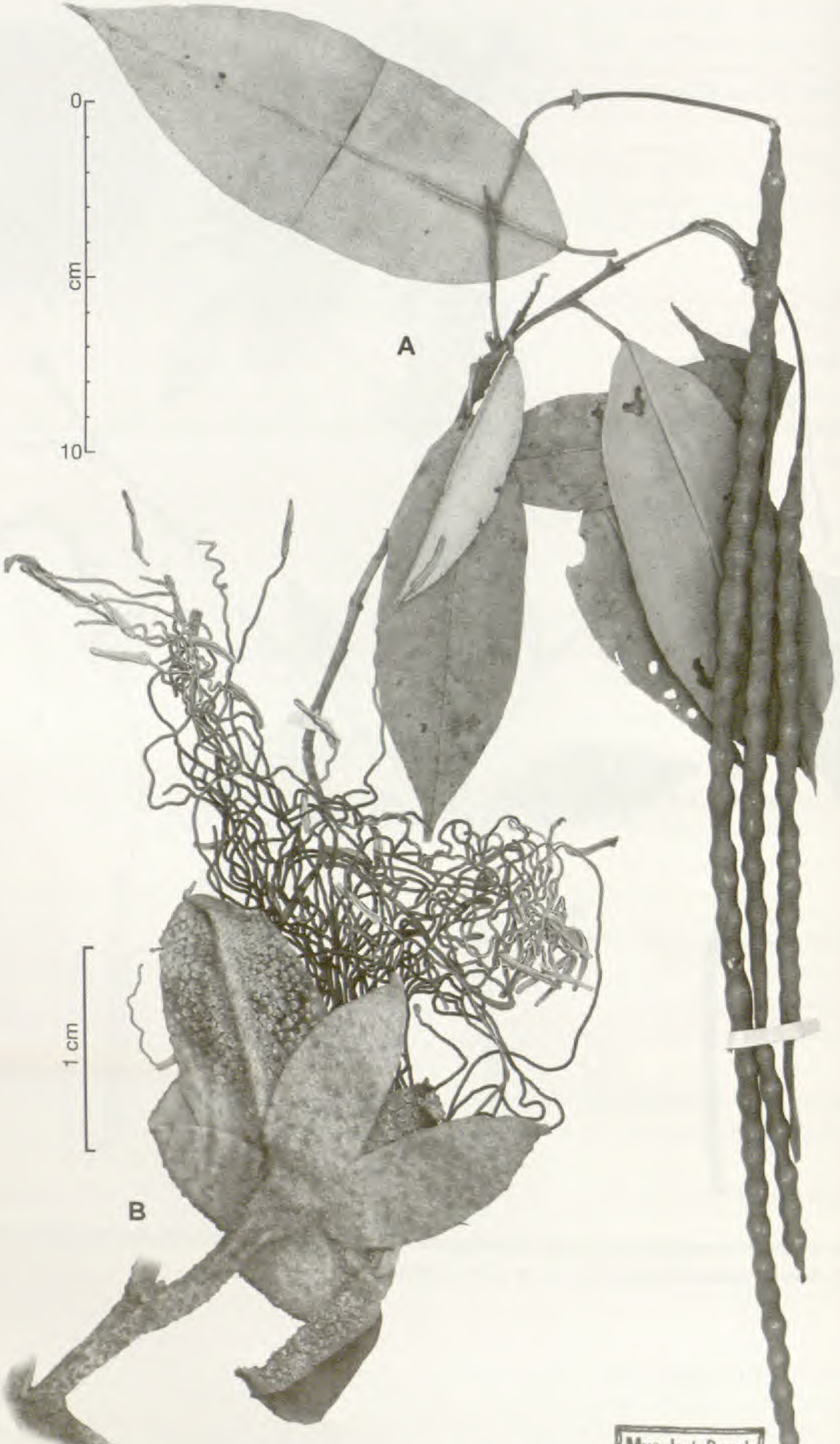

Fig. 11. *Quadrella isthmensis* subsp. *isthmensis*: A. Fruiting branch with long gynophores and torulose capsules. B. Close-up of a dried flower, showing the characteristic, abaxially densely lepidote petals (A: *Hoffmann 755*, B. B: *Haber & Zuchowski 9761*, WIS).

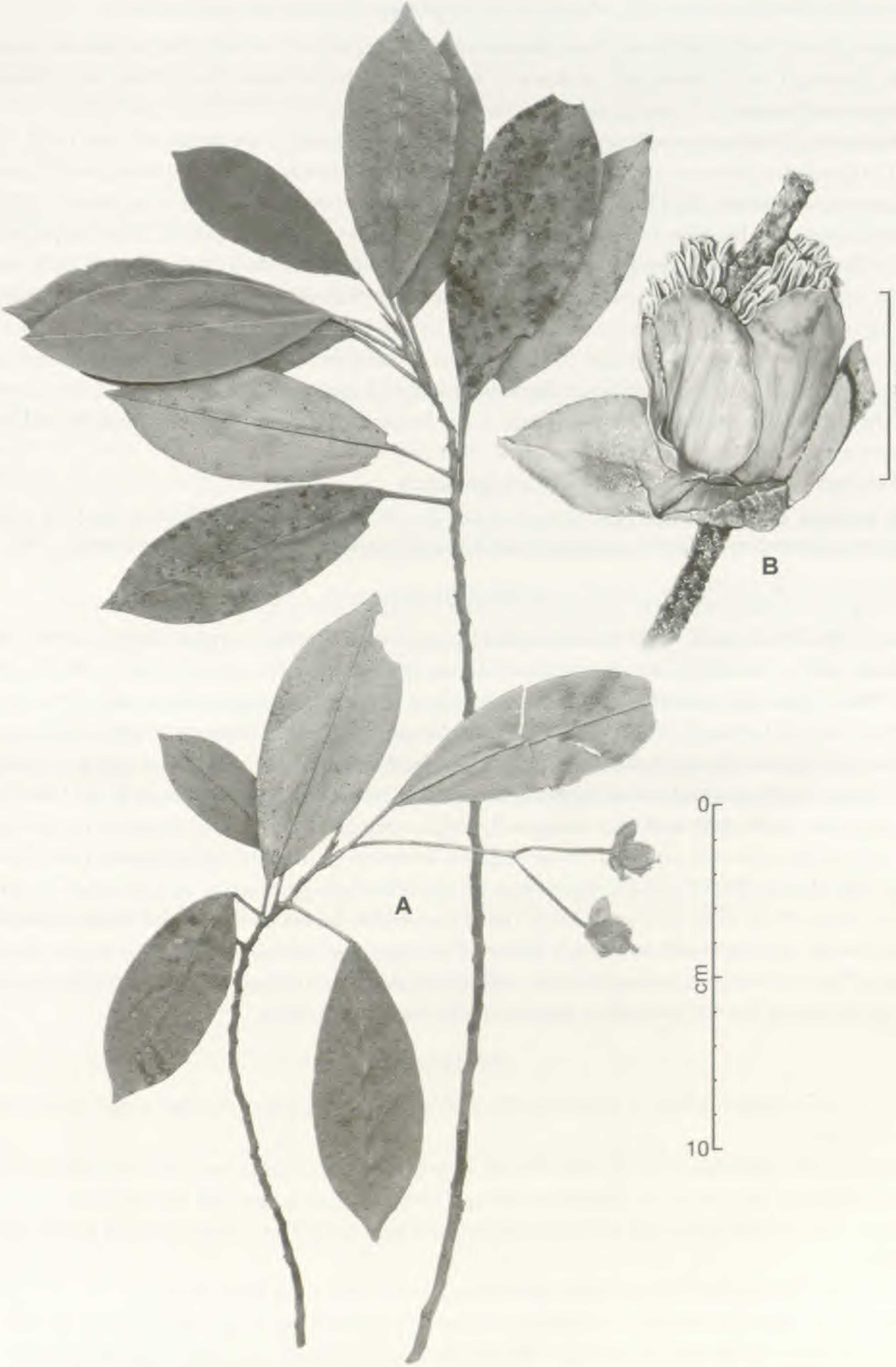

Fig. 12. Isotype of *Quadrella isthmensis* subsp. *glabripetala* (*Hampshire & Whitefoord 111*, WIS): **A.** Flowering and sterile branches. **B.** Close-up of dried, pre-anthesal flower with frontal sepal removed, exposing the characteristic, completely glabrous petals.

Subspecies affinis *Quadrella isthmensis* subsp. *isthmensis* (Eichler) Hutchinson, a qua differt petalis glaberrimus.

Leaf blades (5–)7–13 × (2–)3–4.5 cm, matte above when dry, on petioles 1.5–3 cm; inflorescences on peduncles 2–6 cm, bearing 1 to 2 flowers each; pedicels 3–4.2 cm; floral bracts linear, ca. 2.5 mm, soon deciduous. Sepals tomentulose adaxially, and petals glabrous abaxially; stamens ca. 30. Fruits not known.

Habitat and Distribution.—*Quadrella isthmensis* subsp. *glabripetala* is an apparently rare taxon, closely related to *Quadrella isthmensis* subsp. *isthmensis*, differing mainly by the strikingly obvious total absence of peltate hairs on the petals. That feature would seem to be trivial, were it not that the three known collections are widely spaced out for some 250 km along the crest of Panama's Cordillera Central, from the provinces of Coclé to Chiriquí, occuring at elevations from 500 to 1200 m, and are therefore also ecologically differentiated from the many other, and all coastal, Panamanian collections of *Quadrella isthmensis* subsp. *isthmensis* (Fig. 9C). This new subspecies is restricted to Panama and do not occur at higher elevations in Costa Rica.

According to one of the paratype collectors (Ken Sytsma, pers. comm.), *Quadrella isthmensis* subsp. *glabripetala* was collected at ca. 1400 ft. at the lower edges of dense, fairly wet, undisturbed cloud forests in one of the richest areas of endemism in Panama, a well known hot spot, thus now enriched by still another taxon.

Phenology.—Flowering from February through March.

Paratypes: **PANAMA. Cocle:** Coclé, Cerro Pilón, hill below summit, above El Valle de Antón, 28 Mar 1969, *J.D. Dwyer, L.H. Durkee, T.B. Croat, & J.R. Castillon 4545* (MO); above La Pintada, peak E Llano Grande-Toabré hwy, *W. D'Arcy & K. Systma 14706* (MO , PMA, WIS).

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BOOK REVIEW

Carol KaesukYoon. 2009. **Naming Nature: The Clash Between Instinct And Science**. (ISBN: 978-0-393-06197-0, hbk.). W.W. Norton & Company, Inc., 500 Fifth Avenue, New York, New York 10110, U.S.A. (**Orders:** www.wwnorton.com, 1-800-233-4830, 1-212-869-0856 fax). $27.95, 352 pp., 6 1/2" × 9 1/2".

Contents:

1. The Strange Case of the Fish That Wasn't

The Search for the Natural Order Begins

2. The Little Oracle
3. Miracle in a Barnacle
4. What Rock Bottom Looks Like

A Vision Illuminated

5. A Surprise in the Tower of Babel
6. The Umwelf Among Babies and the Brain-Damaged
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8. Taxonomy by the Numbers
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10. The Death of the Fish

A Vision Reclaimed

11. This Strange Station
12. Beyond Science

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Naming Nature covers the history and psychology behind taxonomy. The broad range of topics Yoon covers makes this book an interesting read not only for general taxonomists but psychologists as well. Yoon recounts rich taxonomic and evolutionary history from masters Linnaeus and Darwin. She does a wonderful job explaining the relationship between taxonomy and evolution with thought provoking history. She also discusses the psychology and parts of the brain associated with naming objects, animate and inanimate. Some of the most interesting parts of this text involve how people who have suffered brain damage perceive the living world and how fish have tortured taxonomists.—*Rebecca Swadek, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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STUDIES IN THE CAPPARACEAE XXIX: SYNOPSIS OF *QUADRELLA*, A MESOAMERICAN AND WEST INDIAN GENUS

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ABSTRACT

Quadrella (DC.) J. Presl (Capparaceae) is validated as an American genus of 25 species, characterized by the stellate to lepidote-peltate indumenta, flowers with valvate calyces, dehiscent fruits bearing seeds with green, white or cream embryos, a haploid chromosome number of $n = 8$, and a diploid one of $2n = 16$. The following taxa are transferred from New World *Capparis* L. s.l. to *Quadrella*: **Quadrella** subg. **Breyniastrum** (DC.) Iltis, comb. nov., **Quadrella antonensis** (Woodson) Iltis & Cornejo, comb. nov., **Quadrella asperifolia** (K. Presl) Iltis & Cornejo, comb. nov., **Quadrella calciphila** (Standl. & Steyerm.) Iltis & Cornejo, comb. nov., **Quadrella filipes** (Donnell Smith) Iltis & Cornejo, comb. nov., **Quadrella indica** (L.) Iltis & Cornejo, comb. nov., **Quadrella lundellii** (Standl.) Iltis & Cornejo, comb. nov., **Quadrella mirifica** (Standl.) Iltis & Cornejo, comb. nov., **Quadrella pringlei** (Briquet) Iltis & Cornejo, comb. nov., **Quadrella steyermarkii** (Standl.) Iltis & Cornejo, comb. nov.; **Quadrella** subgenus **Intutis** (Raf.) Iltis, comb. et stat. nov., **Quadrella angustifolia** (Kunth) Iltis & Cornejo, comb. nov., **Quadrella domingensis** (Spreng. ex DC.) Iltis & Cornejo, comb. nov., **Quadrella domingensis** subsp. **grisebachii** (Eichler) Iltis & Cornejo, comb. nov., **Quadrella ferruginea** (L.) Iltis & Cornejo, comb. nov., **Quadrella ferruginea** subp. **cubensis** (R. Rankin) Iltis & Cornejo, comb. nov., and **Quadrella singularis** (R. Rankin) Iltis & Cornejo, comb. nov. Lectotypes are designated for *Octanema* Raf., *Pleuteron* Raf., *Quadrella asperifolia*, *Q. filipes*, *Q. lundellii*, and *Capparis intermedia* Kunth. Neotypes are designated for *Quadrella* and *Intutis* Raf. All species of *Quadrella* are geographically restricted to southern North America (Texas and Florida), Central America to northern South America (Colombia and Venezuela) and the West Indies. Keys to all the subgenera, species and subspecies of *Quadrella* are herewith provided.

RESUMEN

Se valida *Quadrella* (DC.) J. Presl (Capparaceae), un género que comprende 25 especies, caracterizadas por presentar un indumento de tricomas estrellados hasta lepídoto-peltados, flores con cálices valvados, frutos dehiscentes con semillas de embriones verdes, blancos o cremas y un número cromosómico haploide de $n = 8$, y uno diploide de $2n = 16$. Se transfieren las siguientes taxa de *Capparis* L. s.l. del Nuevo Mundo a *Quadrella*: **Quadrella** subg. **Breyniastrum** (DC.) Iltis, comb. nov., **Quadrella antonensis** (Woodson) Iltis & Cornejo, comb. nov., **Quadrella asperifolia** (K. Presl) Iltis & Cornejo, comb. nov., **Quadrella calciphila** (Standl. & Steyerm.) Iltis & Cornejo, comb. nov., **Quadrella filipes** (Donnell Smith) Iltis & Cornejo, comb. nov., **Quadrella indica** (L.) Iltis & Cornejo, comb. nov., **Quadrella lundellii** (Standl.) Iltis & Cornejo, comb. nov., **Quadrella mirifica** (Standl.) Iltis & Cornejo, comb. nov., **Quadrella pringlei** (Briquet) Iltis & Cornejo, comb. nov., **Quadrella steyermarkii** (Standl.) Iltis & Cornejo, comb. nov.; **Quadrella** subgenus **Intutis** (Raf.) Iltis, comb. et stat. nov., **Quadrella angustifolia** (Kunth) Iltis & Cornejo, comb. nov., **Quadrella domingensis** (Spreng. ex DC.) Iltis & Cornejo, comb. nov., **Quadrella domingensis** subsp. **grisebachii** (Eichler) Iltis & Cornejo, comb. nov., **Quadrella ferruginea** (L.) Iltis & Cornejo, comb. nov., **Quadrella ferruginea** subp. **cubensis** (R. Rankin) Iltis & Cornejo, comb. nov., y **Quadrella singularis** (R. Rankin) Iltis & Cornejo, comb. nov. Se lectotipifican *Octanema* Raf., *Pleuteron* Raf., *Quadrella asperifolia*, *Q. filipes*, *Q. lundellii*, y *Capparis intermedia* Kunth. Se neotipifican *Quadrella* y *Intutis* Raf. Todas las especies de *Quadrella* están geográficamente restringidas al Sur de América del Norte (Texas y Florida), América Central hasta el norte de América del Sur (Colombia y Venezuela) y las Indias Occidentales. Se proveen claves de identificación para todos los subgéneros, especies y subespecies aquí tratadas.

Key Words: *Quadrella*, subgenera *Breyniastrum*, *Intutis*, Capparaceae, Mesoamerica, West Indies

Quadrella (DC.) J. Presl (Capparaceae) is an American genus characterized by the combination of complex, tufted, stellate to peltate, or candelabroid to dendroid trichomes, a valvate or reduplicate calyces and dehiscent capsules bearing seeds with green, white or cream embryos. *Quadrella* comprises three subgenera linked by their inter-digitating morphologies (Table 1), and 25 species distributed from southern North America (Texas and Florida) through Central America to Panama, northern Colombia and Venezuela, and throughout the West Indies (Iltis & Cornejo 2007a: 452).

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TABLE 1. Morphological comparison of *Quadrella* subgenera *Quadrella*, *Breyniastrum* and *Intutis*.

	Quadrella	**Breyniastrum**	**Intutis**
Pubescence complex	peltate	usually tufted or stellate, few times to peltate	stellate to candelabroid
Calyx aestivation (valvate)	closed until anthesis	open when young	open or covering the petals in bud
Sepal shape	oblong, lanceolate to ovate	triangular to linear or filiform	triangular to linear, or oblong to lanceolate
Stamens number	16 to 60	8 to 40	usually 8, ca. 16 (in *Q. singularis*)
Fruit shape, dehiscence, and length	linear to oblong, ± torulose, to 60 cm	linear to linear-oblong, ± torulose rarely ovoid, to 40 cm	ovoid or obovoid to oblongoid or shortly ellipsoid, usually to 3 cm (to 10 cm only in *Q. angustifolia*)
Embryo color	green	green	white or cream
Testa	thin and soft	thin and soft	hard and brittle

Calyx characters in New World capparid taxonomy have been important. Used first by de Candolle (1824) for closed vs. open calyx aestivation, then by Eichler (1865) for his stellate- to peltate-pubescent subgenera, and since then by subsequent workers (e.g., Hutchinson 1967). As an example we may take valvate calyx aestivation, the condition in which the four sepals develop in a single series with their parallel margins adjoining one another to tightly appressed or even reduplicate, but with the margins never overlapping. The calyx may then a), either stop growing from early on, to be rapidly exceeded by the corolla bud and thus ending up with small, ± triangular sepals producing a calyx aestivation that is open ("aperta," Robert Brown 1826: 220), this the hallmark of *Quadrella* subg. *Breyniastrum* (DC.) Iltis and half of the species in *Quadrella* subg. *Intutis* (Raf.) Iltis; or b), continue to grow and enclose the corolla bud and result with a calyx aestivation that is closed until shortly before anthesis, this the hallmark of *Quadrella* subgenus *Quadrella*.

The valvate calyx is one of the primary unifying characters of *Quadrella*, with the closely adjoining sepals meeting exactly but never overlapping. Although, this character is present in *Quadrella* subg. *Quadrella* and half of the species of *Q.* subg. *Intutis* (*Q. angustifolia* [Kunth] Iltis & Cornejo, *Q. alaineana* Cornejo & Iltis and *Q. singularis* [R. Rankin] Iltis & Cornejo), where the relatively large sepals result in a valvate or reduplicate calyx with closed aestivation until anthesis, in the majority of species (subg. *Breyniastrum* and the remaining three species of subg. *Intutis*), the calyx aestivation is open, with the very short, triangular to linear sepals not enclosing the petal bud. Admittedly, while calyx aestivation is distinctive, nevertheless those calyx types are valvate, and the differences are subtle and not significant enough to break up the genus *Quadrella* into two genera, as has been done, whether at the sectional level by de Candolle (1824) or at the generic level by Hutchinson (1967).

The complex lepidote-peltate pubescence that unites *Quadrella* subg. *Quadrella* is clearly a specialization of once stellate or tufted pubescence types fused into lepidote or peltate, multicelular scales as they occur in great diversity in *Quadrella* subg. *Breyniastrum*. Nevertheless, comparing *Q. odoratissima* (Jacq.) Hutch. and *Q. cynophallophora* (L.) Hutch. of *Quadrella* subg. *Quadrella*, their respective peltate trichomes are so distinctive that we must conclude that they most probably evolved independently in these two taxa. Similarly, we can separate out the stellate or peltate pubescent groups from those that are characterized by stellate-tufted (e.g., *Quadrella* subg. *Breyniastrum*) or the stellate-candelabra types of pubescence (e.g., *Quadrella* subg. *Intutis*). Much like the basic ubiquitous ($n = 8$) chromosome number, these are conservative characters not easily subject to change (Iltis & Cornejo 2007b).

Stellate to peltate pubescence evolved, especially in *Quadrella*, into an astonishing diversity of morphological trichome types that obliterate the sectional division (de Candolle 1824) imposed by the closed vs. open aestivation of the calyx. Pubescence varies from simple stellate hairs to complex, stemmed, bottlebrush hairs in subg. *Intutis*, in a continuum from ca. 20 plus, simple, unbranched but tufted hairs on a short stem through complex intermediates to semi-peltate or peltate trichomes in subg. *Breyniastrum* (e.g., *Q. indica* [L.]

Iltis & Cornejo), to end in the massive shield-shaped peltate hair types of subg. *Quadrella*, reminiscent of the indumenta in the Brassicaceae Burnett and *Croton* L. of the Euphorbiaceae Juss. (Webster et al. 1996). Close examination of trichomes types has not been studied in Capparaceae since Vesque in the late 1800s (Vesque 1882) and recently by Rankin & Greuter (2004, as *Capparis* sect. *Breyniastrum* [DC.] Eichler), for *Quadrella* subg. *Intutis*.

The number of stamens in *Quadrella* varies from eight to ca. 60, with eight-staminate species scattered throughout subgen. *Breyniastrum* (three of 13 species), and predominant in subgen. *Intutis* (all species except *Q. singularis*). The eight-staminate condition, otherwise infrequent in Capparaceae, is considered here to be the basic primitive condition often linked with stellate pubescence (see above). The multi-staminate condition may reflect a derived state due to "dedoublement" (chorosis) of eight staminal intials and a specialization that in its extreme is often linked to peltate pubescence, e.g., in *Quadrella isthmensis* (Eichler) Hutch.

In *Quadrella*, the seed is often surrounded by a bright red or orange aril (or sarcotesta and/or pulp), but exactly what that structure is, and from what it is derived, we must leave to the morphological insights of others.

One character related to seed dispersal is the nature of the testa. In *Quadrella* subg. *Intutis*, seeds have a hard testa that encloses a white or cream embryo that is presumably ingested and then expelled with the feces. In contrast, in species of subg. *Quadrella* and *Breyniastrum*, the testa is relatively thin and in some species easily removed to expose a naked green embryo that, apparently acrid and bad tasting, is soon spit out. This suggests a short embryo viability (Linnaeus 1779, 4: 9–10) that made horticultural introduction from the New World across the Atlantic via sail ship unsuccessful.

Even though only sparingly investigated, the number of chromosomes has turned out to be, as in many angiosperm groups, one of the most significant characters defining the stellate-pubescent Capparaceae (Iltis & Cornejo 2007b). In *Quadrella*, the chromosome number of $n = 8$ (or $2n = 16$, from root tips) is herewith reported for *Q. antonensis* (Woodson) Iltis & Cornejo, *Q. isthmensis* (Eichler) Hutch. subsp. *isthmensis*, and *Q. odoratissima* (Jacq.) Hutch. In addition to this cytological information, the following other Neotropical genera of Capparaceae, all characterized by having a stellate or peltate pubescence, have the same chromosome number: *Atamisquea emarginata* (DC.) Miers ex Hook & Arn. (Kers 2003), *Beautempsia avicennifolia* (Kunth) Gaudich. (*Iltis & Iltis E-20*, WIS), *Capparicordis crotonoides* (Kunth) Iltis & Cornejo (*Iltis & Iltis E-15*, WIS), *Colicodendron yco* Mart. (*Mori et al. 11218*, WIS), *C. scabridum* (Kunth) Seem. (*Iltis & Iltis 243*, WIS), *Neocalyptrocalyx longifolium* (Mart.) Cornejo & Iltis (*Mori et al. 11205*, WIS), and *Preslianthus pittieri* (Standl.) Iltis & Cornejo (*Judziewicz 4555*, WIS). On the other hand, the generic type of *Capparis*, *Capparis spinosa* L. has reportedly $2n = 38$ (Al-Turki et al. 2000), with base numbers that are neither $n = 8$ nor 16.

TAXONOMIC TREATMENT

Quadrella (DC.) J. Presl in Berchtold & J. Presl, Prir. Rostlin 2:260. 1825. BASIONYM: *Capparis* sect. *Quadrella* DC., Prodr. 1:251. 1824. *Capparis* subg. *Quadrella* (DC.) Eichler in Martius, Fl. Bras. 13:269. 1865. TYPE: *Quadrella jamaicensis* (Jacq.) J. Presl (=*Capparis jamaicensis* Jacq.) (NEOTYPE, designated here).

Shrubs to small trees, pubescent throughout, with abundant lepidote-peltate to variously stellate or tomentose tufted hairs, with several trichomes types often intermixed at least when young, especially on the underside of the leaves. Leaves various, lanceolate to narrowly to broadly elliptic or oblong. Calyx valvate, with the 1-seriate 4 sepals either larger, lanceolate and with closed aestivation, covering the corolla until anthesis (subg. *Quadrella* and *Q. angustifolia*, *Q. alaineana* and *Q. singularis*, of subg. *Intutis*), or small, triangular to linear and with an open aestivation, exposing the corolla from early on (subg. *Breyniastrum* and the remaining species of subg. *Intutis*). Disk of 4 separate and erect episepalous scales arranged on a flat receptacle; stamens 8 to 60. Capsules linear-cylindric, often torulose, to 60 cm (in subgenera *Quadrella* and *Breyniastrum*, except *Q. morenoi* Cornejo & Iltis), or fruits short and ovoid to shortly oblongoid, to 3(–10, *Q. angustifolia*) cm (in subg. *Intutis*), dehiscent (rarely tardily so) along one or both sutures; valves fleshy with reddish pulp; seeds alternating from both repla but usually arranged in a single row, oblong with shallow or obsolete testa invagination, the embryo straight or slightly curved, green (subgenera *Quadrella*, *Breyniastrum*) or white (subg. *Intutis*).

Quadrella was originally established by de Candolle (1824) as a neotropical section of *Capparis* L. s.l. In *Capparis* sect. *Quadrella* DC., de Candolle accepted seven *Capparis* species (numbered 92–98), but not *C. cynophallophora*. However, under species 95, *C. breynia* L., he does list in synonymy *Breynia indica* L. (=*Quadrella indica* [L.] Iltis & Cornejo) and *C. cynophallophora* (=*Q. cynophallophora*), evidently confusing *Q. cynophallophora* and *Q. indica*.

The elevation of *Capparis* sect. *Quadrella* to generic status occurred a year later (1825), and with it the transfer of seven species in Volume 2 of a very rare Czech work, written in the rare Bohemian language, O Prirozenosti Rostlin by the world traveler and amateur botanist, Friedrich Berchtold (1781–1876), and his junior co-author, Jan Swatopluk Presl (1791–1849). The latter, the trained taxonomist of the pair, is the one to whom the genus and new combinations are credited. In Flora Brasiliensis, Eichler (1865) reduced *Quadrella* to a subgenus of *Capparis*, but 102 years later, Hutchinson (1967), in his generic realignment of Capparaceae, recognized *Quadrella* as a valid genus.

Hutchinson (1967) designated *Quadrella cynophallophora* as the lectotype of the genus *Quadrella*, with *Quadrella jamaicensis* in synonymy under the former species. However, *Quadrella cynophallophora* was not cited by Presl when the genus was established, therefore Hutchinson's lectotypification of *Quadrella* is not valid, because was not based on Presl's original material for the name. We designate *Quadrella jamaicensis* the neotype for this genus, which was previously cited by de Candolle (1824), in *Capparis* sect. *Quadrella*, by Eichler (1865) under *Capparis* subg. *Quadrella*, by Presl (1825) under *Quadrella*, and by Hutchinson (1967) as a synonym of his lectotype *Quadrella cynophallophora*.

Inocencio et al. (2006) state that *Quadrella crotonoides* (Kunth) Presl (=*Capparicordis crotonoides* [Kunth] Iltis & Cornejo) is the type of *Quadrella*. However, in the cited literature, there is no such designation of this species as type for this genus. Their typification was not explicitly cited with the phrase "designate here" (as must be for accepted lectotypifications on or after 1 Jan 2001, in accordance to the Art. 7.11 of the Vienna Code [McNeill et al. 2006]), therefore *Quadrella crotonoides* is not the type for this genus. Finally, in our concept of *Quadrella*, which follows most of the species cited by de Candolle and Presl, and all of Eichler's and Hutchinson's, *Quadrella crotonoides* doesn't belong to the genus *Quadrella* at all (see rejected names).

A molecular work (Hall 2008) has demonstrated that the genus *Quadrella* is related to some Neotropical taxa of Capparaceae characterized by the presence of stellate to peltate indumenta, such as: *Capparicordis* Iltis & Cornejo, *Calanthea* (DC.) Miers, *Colicodendron* Martius, *Morisonia* L, and *Steriphoma* Spreng.; and that those genera, jointly with all remaining Neotropical species also formerly placed in *Capparis*, represent a separate lineage that is not closely related to that of the Old World *Capparis*, including *C. spinosa* L., the generic type. That molecular evidence is also consistent with the morphology of all Neotropical genera of Capparaceae (including *Quadrella*), in which, in contrast, it is evident the absence of the following characters that are present in *Capparis spinosa*: 1) A pair of retrorse stipular spines; 2) flowers with one galeate (helmet-shape) sepal; 3) only a single nectary gland with its apex directed towards the interior of the flower; and 4) two of the four petals having an irregular shape, with their asymmetrical bases laterally connate to each other and folded, forming a petaloid hood-like structure that partially envelops and protects the solitary nectary gland (Cornejo & Iltis 2009a). Thus, those morphological and molecular differences make it impossible to continue using the name *Capparis* for the Neotropical species traditionally assigned to that generic name. A key to *Quadrella* and related Neotropical genera with stellate to lepidote-peltate indumenta is provided in Cornejo & Iltis (2009b).

KEY TO THE SUBGENERA OF *QUADRELLA*

1. Indument of terminal branches and leaf blades (at least abaxially) of peltate-lepidote trichomes; calyx with closed aestivation, the sepals lanceolate to oblong or ovate, covering the corolla until anthesis ____ **I. Quadrella** (DC.) J. Presl subg. **Quadrella**

1. Indument of terminal branches and leaf blades (at least abaxially) of stellate to candelabra trichomes; calyx usually with open aestivation and much exceeded by the corolla bud, the sepals usually triangular to linear, distinctively smaller than the petals from buds (except *Q. angustifolia*, *Q. alaineana* and *Q. singularis*).
   2. Seeds oblongoid or ellipsoid, sometimes cleomoid-reniform, with ± green embryo; fruits usually linear to linear-oblong, (1.3–)5–40 cm, usually several to many-seeded (except *Q. morenoi*); stamens 8 to 60 ______ **II. Quadrella** subg. **Breyniastrum** (DC.) Iltis
   2. Seeds cleomoid-reniform, with white or cream embryo; fruits ovoid to obovoid or shortly oblongoid, 1–3 cm, 1- to 6-seeded; stamens usually 8, or ca. 16 (*Q. singularis*). ______ **III. Quadrella** subg. **Intutis** (Raf.) Iltis

I. **Quadrella** (DC.) J. Presl subg. **Quadrella**

The subgenus *Quadrella* is characterized by the combination of the following characters: Closed valvate calyx aestivation, with oblong, lanceolate u ovate sepals, that at or after anthesis tend to recurve and fall off; peltate-lepidote trichomes; usually ± torulose capsules; and seeds with green embryos. It comprises 7 species and 3 subspecies.

Distribution. Mexico, Central America, Florida, the West Indies and northern-most South America, mostly of arid places.

KEY TO SPECIES IN *QUADRELLA* SUBG. *QUADRELLA*

1. Calyces ± quadrate, with 4 fairly sharp ridges; peltate indumentum rusty brown or golden brown; gynophores 1 to 8 cm (absent or to 5 mm only in *Q. quintanarooensis*).
   2. Ovaries at anthesis 3–6.5 mm; sepals 5–10(–11) mm; receptacle in fruits (2–)3–5(–6) mm wide; stamens 16–35(–40); leaf blades mostly lustrous above, usually uniformly lepidote or peltate green or brownish beneath. Florida, through the West Indies to Trinidad and Barbados; disjunct to Mexico's Yucatan Peninsula and Quintana Roo, not uncommon locally on Cozumel Island and on the immediate adjoining northeastern coastal mainland.
      3. Flowers large, with petals 8–17 mm and sepals (5–)7–11 mm; stamens with simple or few-branched stellate trichomes at the base of the filament; anthers (2–)3–4 mm; southern Florida, West Indies and northeastern Yucatan Peninsula, Mexico.
         4. Gynophores in flower conspicuous, 10–50 mm, to 80 mm in fruits; filaments 20–50 mm; petals 10–17 mm; common throughout the West Indies and southern Florida.
            5. Leaf blades 3–8(–10) × 1–4(–4.5) cm, elliptic to narrowly obovate or oblong, rarely lanceolate (linear to lanceolate [to 17 cm] in juvenile leaves or stump sprouts), stiffly coriaceous and revolute, lustrous above; petioles 1–2 cm; seeds 5–8 × 4–6 mm, packed in near each other in mostly barely torulose siliques; throughout the West Indies and southern Florida, in Jamaica, as elsewhere, mostly in coastal lowlands.
               6. Leaf blades ± elliptic, mostly 5–10 × 2–6 cm, with apex acuminate or acute, sometimes obtuse to rounded but then often apiculate and not emarginate; central and eastern West Indies, from the Bahamas and Hispaniola to Puerto Rico and on to Trinidad and Barbados, sympatric with the following in Hispaniola ______ **Quadrella cynophallophora**
               6. Leaf blades mostly oblong or oblong-elliptic, mostly 3–7(–9) × 1–3(–3.5) cm, with apex usually emarginate (notched) to rounded; southern Florida, Cuba, Jamaica, and the Cayman and Swan islands, sympatric with the preceding species in Hispaniola and rarely in the Bahamas ______ **Quadrella jamaicensis**
            5. Leaf blades 7–15(–20) × 4–9 cm, ± broadly elliptic, ± chartaceous, rather opaque above, on petioles (1.5–)2–4 cm; seeds 7–15 × 6–9 mm, spaced out in strongly torulose siliques; highlands of Jamaica at 200–800 m (500–2600 feet), in mesic to moist montane woodlands and limestone savannas ______ **Quadrella siliquosa**
         4. Gynophores in flower and fruit highly reduced to 5 mm or less or lacking; filaments 6–15 mm; petals 8–9 mm; endemic to Cozumel Island and immediately adjoining mainland of Quintana Roo, northeastern Yucatan Peninsula, Mexico ______ **Quadrella quintanarooensis**
      3. Flowers small, delicate, with petals 6–7 mm and sepals 5 mm; stamens with densely lepidote-radiate or lepidote-stellate (many-branched) trichomes at filament base; anthers 1–2 mm; very rare, scattered eastern half of Hispaniola (Haiti and easternmost Dominican Republic) ______ **Quadrella gonaievensis**
   2. Ovaries at anthesis 6.5–10 mm; sepals (9–)10–18 mm; receptacle in fruits 5–10 mm wide; stamens ca. 30–60; leaf blades opaque above (except *Quadrella isthmensis* subsp. *mexicana*), silvery lepidote peltate beneath, with scattered darker bronze hairs giving the lower surface a peppered appareance. Panama

and Costa Rica, and disjunct to the central Yucatan Peninsula (northern Guatemala and Belize) north to the Caribbean coast of Mexico's Yucatan State.

7. Petals completely glabrous without, sepals tomentulose within; very rare, on or near the crest of the Cordillera Central of western Panama, at 500–1200 m ____________ **Quadrella isthmensis** subsp. **glabripetala**
7. Petals densely lepidote without, sepals tomentose within; eastern Mexico, from northern Yucatan and Campeche south into Guatemala and Belize; and, disjunct, to Costa Rica and the lowlands of Panama.
    8. Flower larger, with petals 12–18 × 7–10 mm, stamens 4–7 cm, and gynophores 4–8 cm; fruits to 60 cm, on gynophores 4–8 cm, and pedicels (1.3–)2–4.5 cm; mature leaf blades (5–)8–21(–26) cm, opaque above (when dry); Costa Rica and lowlands of Panama _____ **Quadrella isthmensis** subsp. **isthmensis**
    8. Flowers smaller, with petals 9–13 × 6–7.5 mm, stamens 2–4(–4.5) cm and gynophores 1–4.5 cm; fruits to 23 cm long, on gynophores 2–4(–5.5) cm and pedicels 1–2 cm; mature leaf blades 6–15 cm, often lustrous above (when dry); northern and central Yucatan Peninsula of Mexico to adjacent Guatemala and Belize ____________________________ **Quadrella isthmensis** subsp. **mexicana**

1. Calyx ± round, not ridged; peltate indumentum golden to silvery; gynophores absent ______ **Quadrella odoratissima**

1a. Quadrella cynophallophora (L.) Hutch., Gen. Fl. Pl. 2:309. 1967, sensu stricto. BASIONYM: *Capparis cynophallophora* L., Sp. Pl. ed. 1, 504. 1753; ed. 2:721, 1762, non *Capparis cynophallophora* Jacq., Select. Stirp. Amer. t. 98. 1763, which is *C. flexuosa* (L.) L., =*Cynophalla flexuosa* (L.) J. Presl, 1825. TYPE: JAMAICA?: Left hand specimen, "*Capparis* 2," Hortus Cliffortianus Hb. (LECTOTYPE, designated by Iltis & Cornejo 2010, BM-628728).

Quadrella cynophallophora is a widespread, polymorphic species, ranging from the Bahamas through the Dominican Republic (Hispaniola) and the Lesser Antilles to Trinidad and Barbados (in the latter two apparently known mostly from cultivated or escaped plants), generally at low elevations near the ocean, but to 400 m in Dominican Republic. Locally rarely sympatric with the similar *Quadrella jamaicensis* (Jacquin) J. Presl, in the Bahamas and the Dominican Republic, it can be distinguished by its mostly pointed, acute to obtuse, but not emarginate leaves.

Quadrella cynophallophora occurs in central and eastern West Indies, from the Bahamas to Hispaniola (where intergrades with *Quadrella jamaicensis*) and the southern coast of Puerto Rico and through the Lesser Antilles to Trinidad and Barbados (Gooding et al. 1965), mostly in coastal, seasonally dry, evergreen woodlands, but also in a great variety of habitats, often cultivated as hedges.

1b. Quadrella cynophallophora (L.) Hutch., f. **linearifolia** Iltis, J. Bot. Res. Inst Texas 4:98. 2010. TYPE: U.S.A. VIRGIN ISLANDS: St. John, East End Quarter, Hansen Bay, (eastern part of the Island at the end of Rt. 10) 0–10 m, dry scrubby coastal environment along a rocky shore, *P. Acevedo-Rodriguez, A Reilly & M. Davis 1808* (HOLOTYPE: NY).

A juvenile or stump sprout form with characteristic linear leaf blades.

2. Quadrella gonaievensis (Helwig) Hutch., Gen. Fl. Pl. 2:308. 1967. BASIONYM: *Capparis gonaïvensis* Helwig, Ark. Bot. 22A:10. 1929. TYPE: HAITI: "Peninsula sept.-occidentalis ad viam inter Les Gonaïves et Hatte-Rocher prope mangrove communis," s.d., *E. Ekman 8483* (LECTOTYPE, B, B fragm. & photo at WIS; duplicates of the LECTOTYPE: GH, IJ, US).

Quadrella gonaievensis is a rare, highly localized but scattered endemic of Haiti and adjacent western parts of the Dominican Republic. This species has usually been ignored completely, or listed in synonymy under *Q. cynophallophora* (Urban 1920–21: 239; Al-Shehbaz 1988; Rankin & Greuter 2004). However, *Quadrella gonaievensis* differs of *Q. cynophallophora* by having small, delicate flowers, with petals 6–7 mm (vs. ca. 9–10 mm); stamens with densely lepidote-radiate or lepidote-stellate, many branched (vs. densely pilose with simple) trichomes at the filament base; and smaller anthers, 1–2 mm (vs. 2–3.5 mm).

3. Quadrella isthmensis (Eichler) Hutch., Gen. Fl. Pl. 2:308. 1967. BASIONYM: *Capparis isthmensis* Eichler in Martius, Fl. Bras. 13:269. 1865. TYPE: COSTA RICA: "Habitat ad Costa Rica et Veraguas Americae Centralis," s.d., *C. Hoffmann & Warszewicz 217* (LECTOTYPE, designated by Iltis & Cornejo 2010a, B, B fragm. at M, WIS).

3a. Quadrella isthmensis (Eichler) Hutch. subsp. **isthmensis**

Capparis chiriquensis Woodson, Ann. Missouri Bot. Gard. 35:92, fig. 49. 1948. TYPE: PANAMA. PROVINCE OF CHIRIQUI: vic. Puerto Armuelles, 0–75 m, 28–31 Jul 1940, *R. Woodson & R. Schery 846* (HOLOTYPE: MO, MO photo at WIS; ISOTYPES: GH, US, US photo at WIS).

Chromosome number.—$2n = 16$ [!Pazy, from root tip]. Panama: Canal Zone, 7 m tree, 10 cm dbh, visited by small bees, trail along Rio Petit Pie, near road to Fort Sherman, on Limestone, upland Panama, *S. Mori & J. Kallunki 5011* (WIS).

Quadrella isthmensis subsp. *isthmensis* is found in Costa Rica, from sea level (Osa Peninsula) to 900 m (Cordillera de Tilaran), generally on the Pacific slope, and in coastal mostly Pacific lowlands of Panama, mostly in wet or moist tropical forests, apparently not overlapping the range of *Q. isthmensis* subsp. *glabripetala*.

3b. Quadrella isthmensis subsp. **glabripetala** Cornejo & Iltis, J. Bot. Res. Inst Texas 4:111. 2010. TYPE: PANAMA. CHIRIQUI: near Fortuna Dam Camp, 26 Feb 1985 (fl), *R.J. Hampshire & C. Whitefoord 111* (HOLOTYPE: MO; ISOTYPES: PMA, WIS).

Restricted to higher elevations and the crest of Cordillera Central in Panama (Cornejo & Iltis 2010a).

3c. Quadrella isthmensis subsp. **mexicana** Cornejo & Iltis, J. Bot. Res. Inst Texas 4:110. 2010. TYPE: MEXICO. YUCATAN: Las Bocas de Silam [Dzilám], May 1916 (fl), *G. Gaumer & sons 23344* (HOLOTYPE: MO; ISOTYPES: BM, F, K, NY, US, US photo at WIS).

Quadrella isthmensis subspecies *mexicana* is one of the successional elements from mangrove borders in Yucatán (*Lira et al. 368*, MEXU) inland to "selvas medianas subperennifolias" (Rzedowski 1978), south to high forests in Guatemala and adjoining Belize.

4a. Quadrella jamaicensis (Jacq.) J. Presl, Prir. Rostlin 2:261. 1825. BASIONYM: *Capparis jamaicensis* Jacq., Enum. Pl. Carib. 23. 1760. TYPE: JAMAICA: t. 101 in Jacquin, 1763 (LECTOTYPE, designated by Al-Shehbaz in Flora of the Lesser Antilles-Dicotyledoneae 4(1):296. 1988).

Capparis emarginata A. Richard in Sagra, Hist. Fis. Cuba 10:28. 1845. TYPE: CUBA: s.d., *Sagra s.n.* (LECTOTYPE: P, designed by Al-Shehbaz in Flora of the Lesser Antilles-Dicotyledoneae 4(1):296. 1988).
Colicodendron anceps Shuttl., nomen in Chapman, Fl. South. U.S. 32. 1860.

Quadrella jamaicensis is an evergreen, ornamental species, known as Jamaica Caper. This species is characteristic of coastal areas from central Florida (from Cape Cañaveral on the east coast and St. Petersburg Beach on the west coast), south to Key West. It also occurs in Cuba, Jamaica, and the Cayman and Swan Islands, overlapping and intergrading with *Quadrella cynophallophora* in Hispaniola, but is rare in the Bahamas (Iltis & Cornejo 2010a).

4b. Quadrella jamaicensis (Jacq.) J. Presl, f. **longifolia** (Swartz) Iltis, J. Bot. Res. Inst Texas 4:98. 2010. BASIONYM: *Capparis longifolia* Swartz, Prodr. 81. 1788. TYPE: JAMAICA: *Swartz s.n.* (HOLOTYPE: S, S photo at WIS; ISOTYPE: C, C photos at IJ, WIS).

This strikingly different-appearing form is a stump sprout or juvenile, sterile branch with narrow elongate leaf blades, common in this species and, in a homologous form, also in *Quadrella cynophallophora* f. *linearifolia*. This form is distributed across the range of the species.

5. Quadrella odoratissima (Jacq.) Hutch., Gen. Fl. Pl. 2:308. 1967. BASIONYM: *Capparis odoratissima* Jacq., Hort. Schoenbr. 1:57, t. 110. 1797. TYPE: VENEZUELA: Caracas, "In caldario, floret Martio & Aprili" (LECTOTYPE, Tab. 110, in Jacquin, loc. cit. designated by Al-Shehbaz, in Flora of the Lesser Antilles-Dicotyledoneae 4(1): 1988).

Capparis intermedia Kunth, Nov. Sp. Pl. 5:98. 1821. *Quadrella intermedia* (Kunth) J. Presl, Prir. Rostlin 2:261. 1825. TYPE: VENEZUELA: "Crescit prope Cumaná," Sep, *A. Humboldt & A. Bonpland 39* (LECTOTYPE, designated here: P).

Chromosome number.—$2n = 16$ [!Pazy, !Przywara, from root tips]. Venezuela: Distrito Federal, shrub 3 m, tropical low deciduous forest, carretera vieja Caracas-La Guaira, 320 m, 4 Feb 1979, *P. Berry & T. Plowman 3363* (MO, WIS).

Quadrella odoratissima is a common and very distinctive silvery-peltate evergreen species with beautiful flowers and sessile siliques, characteristic of arid tropical dry forests, from northern coastal Colombia and Venezuela into the Lesser Antilles, and, in Mesoamerica, from Panama to southern Mexico.

Capparis intermedia is herein synonymized under *Quadrella odoratissima* because both describe the same species, giving priority the older name.

6. Quadrella quintanarooensis Iltis & Cornejo, J. Bot. Res. Inst Texas 4:104. 2010. TYPE: MEXICO. QUINTANA ROO:

Xcaret, a 5 km S de Playa del Carmen, selva mediana, 15 Sep 1982 (fr), *E. Cabrera & H. de Cabrera 3495* (HOLOTYPE: MEXU, MEXU fragm. & photo at WIS; ISOTYPES: CAS, MO).

Quadrella quintanarooensis occurs in dry, open, tropical forests and woodlands on or near beaches at sea level on Cozumel Island and the adjoining Mexican mainland of Quintana Roo (Iltis & Cornejo 2010a).

7. **Quadrella siliquosa** (L.) Iltis & Cornejo, J. Bot. Res. Inst Texas 4:98. 2010. BASIONYM: *Capparis siliquosa* L., Syst. Nat. ed. 10 (2): 1071. 1759, p.p. *Pleuteron siliquosa* (L.) Raf., Sylva Tellur. 109. 1838. TYPE: JAMAICA: road to Troy, 18 Sep 1906, W *Harris 9488* (NEOTYPE, designated by Iltis & Cornejo 2010, BM, BM fragm. & photo at WIS; ISONEOTYPES: A, GH, K, NY, US).

Capparis torulosa Swartz, Prodr. 81. 1788. *Quadrella torulosa* (Swartz) J. Presl, Prir. Rostlin 2:261. 1825. *Pleuteron torulosa* (Swartz) Raf., Sylva Tellur. 109. 1838. TYPE: JAMAICA: s.d. (fr), *C. Wright s.n.* (NEOTYPE, designated by Iltis & Cornejo 2010, S 05-9708).

Endemic to the montane woodlands and savannas of Jamaica (Iltis & Cornejo 2010).

II. **Quadrella** subg. **Breyniastrum** (DC.) Iltis, comb. nov. BASIONYM: *Capparis* section *Breyniastrum* DC., Prod. 1:250. 1824. *Capparis* subg. *Breyniastrum* (DC.) Eichler in Martius, Fl. Bras. 13(1):271, t. 64. 1865, p.p. (excl. *Capparis longifolia*, =*Quadrella jamaicensis* f. *longifolia*). *Breynia* L., Sp. Pl. 1:503. 1753, nom. rej. for *Breynia* J.R. Forster & G. Forster, Char. Gen. Pl., 73. 1775, nom. cons. [Euphorbiaceae]. *Linnaeobreynia* Hutch., Gen. Fl. Pl. 2:310. 1967, p.p. (excl. *L. domingensis* [Spreng. ex DC.] Hutch., *L. ferruginea* [L.] Hutch., *L. grisebachii* [Eichler] Hutch., *L. incana* [Kunth] Iltis & Cornejo, =*Quadrella* subg. *Intutis* [Raf.] Iltis & Cornejo, and *Capparis* sect. *Calanthea* DC., =*Calanthea* [DC.] Miers). TYPE: *Breynia indica* L. (=*Quadrella indica* [L.] Iltis & Cornejo), lectotype, designated by Hutchinson in The Genera of Flowering Plants (Angiospermae). Dicotyledones 2:311. 1967).

Pleuteron Raf., Sylva Tellur. 109. 1838, p.p. (excl. *Capparis frondosa* Jacq., *C. baducca* L., *C. hastata* Jacq., *C. linearis* Jacq., *C. siliquosa* L. [=*Quadrella siliquosa*], *C. comosa* Jacq. (=*Q. ferruginea* [L.] Iltis & Cornejo), *C. torulosa* [=*Quadrella siliquosa*], *C. tenuisiliqua* Jacq.) TYPE: *Pleuteron breynia* (L.) Raf. [=*Quadrella indica* (L.) Iltis & Cornejo], lectotype designated here.

The logical choice of Hutchinson (1967) of *Breynia indica* (=*Quadrella indica*) as the subgenus lectotype (for *Capparis* subg. *Breyniastrum*) preserves traditional useage, while *Capparis ferruginea* L. (=*Quadrella ferruginea*), posteriorly designated as lectotype by Rankin & Greuter (2004: 262, for *Capparis* sect. *Breyniastrum*), introduces an extraneous element belonging to a different taxonomic group that is characterized by a capsular fruits with few seeds containing white embryos surrounded by a ± hard testa, which we now segregate in *Quadrella* subg. *Intutis* (Raf.) Iltis; see below.

Hutchinson (1967), proposed *Linnaeobreynia* as a new generic name for *Breynia* L., a rejected illegal homonym, because *Breynia* J.R. Forster & G. Forster (Euphorbiaceae) is a previously established nomen conservandum. He repeated most of the species included in Eichler's broad but heterogeneous concept of *Capparis* subgenus *Calanthea* (DC.) Eichler, intermixing species with different calyx structure, dehiscent and indehiscent fruits and with seeds of green and white embryos, including *L. pulcherima* (Jacq.) Hutch. (=*Calanthea pulcherrima* [Jacq.] Miers, the type of *Calanthea* [DC.] Miers, a valid South American small genus of Capparaceae characterized by the flowers with widely spaced, linear-ligulate to oblong sepals exposing the valvate corolla from early bud on and fleshy amphisarca, bearing seeds with uncommonly very thick cotyledons [Cornejo & Iltis 2008, 2009]); four species of *Quadrella* subg. *Breyniastrum*: *L. admirabilis* (Standl.) Hutch. (=*Q. lundellii* [Standl.] Iltis & Cornejo), *L. asperifolia* (K. Presl) Hutch. (=*Q. asperifolia* [K. Presl] Iltis & Cornejo, *L. pringlei* (Briq.) Hutch. (=*Q. pringlei* Briquet), and *L. tonduzii* (Briq.) Hutch. (=*Q. indica*); and the following taxa of *Quadrella* subg. *Intutis*: *L. domingensis* (=*Q. domingensis* [Spreng. ex DC.] Iltis & Cornejo), *L. grisebachii* (=*Q. domingensis* subsp. *grisebachii* [Eichler] Iltis & Cornejo), *L. ferruginea* (=*Q. ferruginea* [L.] Iltis & Cornejo), and *L. incana* (=*Q. incana* [Kunth] Iltis & Cornejo).

Pleuteron breynia (=*Quadrella indica*) is herein designated the lectotype of *Pleuteron* because Rafinesque, in the protologue, referred to it as the "main type." *Pleuteron* is synonymyzed under *Quadrella* subgen. *Breyniastrum* because the mentioned selected lectotype has stellate pubescence, flowers with calyx valvate and open aestivation in bud and fruits with seeds containing green embryos.

Quadrella subg. *Breyniastrum* is similar to subg. *Quadrella* in its peltate or stellate pubescence and capsular fruits, but with its retarded calyx growth resulting in small triangular sepals. These, valvate from very early on in development, are soon much exceeded by the corolla, thus leading to an open calyx aestivation at anthesis. Lastly, its dehiscent elongate capsules are filled with sticky red pulp and several to many seeds, these covered by a red or orange aril or endocarp(?) and a thin testa that easily is slipped off the green embryos by the vertebrate dispersers. Twelve species are assigned to this subgenus.

Despite the calyx differences between subg. *Quadrella* (closed calyx aestivation) and subg. *Breyniastrum* (open calyx aestivation), the two sections seem very closely related indeed, considering their similar fruit, pulp, and embryo colors, the nature and color of their seed arils and seed coats, their variable tufted to stellate to peltate-lepidote pubescence and finally their distributional biogeographic coherence.

Distribution. A New World group centered on Mexico and Central America.

KEY TO THE SPECIES OF *QUADRELLA* SUBG. *BREYNIASTRUM*

1. Detritophilous plants, main stem with adventitious roots and spiralate leaves, densely arranged at the end of the stem or branches in pseudoverticils that collect humus; androgynophores and gynophores absent.
  2. Shrubs or branched treelets; leaf blades (12–)15–35(–40) × 3–10(–11) cm; inflorescence a persistent raceme, bracts soon deciduos; filaments 4–5 mm, petals 5–7 mm; Panama, west of the canal **Quadrella antonensis**
  2. Unbranched or sometimes to 2-branched treelets; leaf blades 30–70 × 9–19 cm; inflorescence paniculiform bearing to several few-flowered 2nd order bracteate racemes, soon deciduous if not pollinated, raceme bracts persistent, 3–4 mm; filaments and petals 7–8 mm; Panama, east of the canal. **Quadrella dressleri**
1. Plants not detritophilous, main stem without adventitious roots, leaves alternate to laxly-spiralate, arranged along the branches; androgynophores and gynophores present.
  3. Gynophores 2–10 mm, staminal filaments 5–10 mm.
    4. Petals 4–8 × 2–5 mm, anthers 1.5–2.8 mm.
      5. Flowers with 8 stamens.
        6. Leaf blades (2.5–)3–8.5(–10) × 1–4(–5) cm; petals 4.5–6 mm; fruits broadly ellipsoid to obovoid, 1.3–2.5 × 0.8–1.1 cm **Quadrella morenoi**
        6. Leaf blades 18–27 × 5–10.5 cm; petals 7–8 mm; fruits linear, torulose, 11–31 × 0.6–1 cm **Quadrella steyermarkii**
      5. Flowers with 14–30 stamens.
        7. Leaf blades 0.8–2.5 cm wide, petioles 2–8 mm; filaments 7–10 mm, gynophores golden lepidote; fruits 4–5 mm wide, seeds 5–8 mm **Quadrella lindeniana**
        7. Leaf blades 2–5.5(–8) cm wide, petioles (15–)20–50(–74) mm; filaments 5–7 mm, gynophores lepidote-stellate; fruits 7–15 mm wide, seeds 8–12 mm **Quadrella pringlei**
    4. Petals 12–13 × 8–9 mm, anthers 3–4 mm **Quadrella calciphila**
  3. Gynophores 12–40 mm, staminal filaments 12–30 mm.
    8. Inflorescences erect or suberect, panicles or corymbose racemes; leaves loosely spiralate.
    8. Inflorescences pyramidal panicles, peduncles 2–5 mm wide, longitudinally costate; stamens 8; nectaries dark brown when dry, conspicuous from floral bud; leaf blades with rounded to subcordate base **Quadrella lundellii**
      9. Inflorescences corymbose racemes, peduncles 1–2 mm wide, ecostate; stamens 15–36; nectaries inconspicuous in floral bud; leaf blades with usually cuneate base.
        10. Leaf blades smooth above, lepidote-peltate beneath; ovaries densely covered by appresed lepidote-peltate trichomes **Quadrella indica**
        10. Leaf blades ± scabrous above, stellate and dendroid beneath; ovaries densely covered by stellate multiradiate and lepidote-stellate trichomes **Quadrella asperifolia**
    8. Inflorescence pendulous, umbellate; leaves distichous.
      11. Leaf blades usually with a reddish brown, stellate tomentose, marginal pubescence, anthers 4 mm **Quadrella mirifica**
      11. Leaf blades without a reddish brown, stellate tomentose, marginal pubescence, anthers ca. 2 mm **Quadrella filipes**

1. Quadrella antonensis (Woodson) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis antonensis* Woodson, Ann. Missouri Bot. Gard. 35:90. 1948. TYPE: PANAMA. COCLE: hills N El Valle, 13 Jan 1942, *P.H. Allen 2948* (HOLOTYPE: MO).

Chromosome number.—$2n = 16$ [!Pazy, !Przywara, from root tip]. Panama: Cocle, shrub 2 m, in cloud forest, ca. 3 km NE of El Valle, 2 Nov 1961, *S. Mori & J. Kallunki 2961* (WIS).

A locally common shrub or treelet with subverticillate, overlapping, cordate based leaves that form a trash basket invaded by adventitious roots (detritophily) and home to a mini-botanical garden of mosses, ferns, pepperomias and a mini-zoo of amphibians and diverse invertebrates, such as Collembolas. The plant species is endemic to tropical rain and cloud forests of eastern Panama. It is similar to *Q. dressleri* Cornejo & Iltis, for differences see Cornejo and Iltis (2010). This is apparently a case of convergent evolution allopatrically evolved in the Panamanian area in response to unknown pollinators or other factors, an evolutionary enigma in need of molecular answers (Dressler 1985; Sánchez 2001).

2. Quadrella asperifolia (K. Presl) Iltis & Cornejo, comb. nov. Basionym: *Capparis asperifolia* K. Presl, Reliq. Haenk. 2:86. 1835. *Linnaeobreynia asperifolia* (K. Presl) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: MEXICO: "Habitat ad urbem et portum Acapulco," Jun 1834, *T. Haenke s.n.* (lectotype, designated here, PR; duplicates of the lectotype: MO 3835176, W, W photo at F 030115).

Capparis langlassei Briquet, Ann. Jard. Bot. Geneve 17:392. 1914, syn. nov. Type: MEXICO. Michoacan: Cuesta de Cijones, 1000 m, 14 Apr 1899 (fl), *E. Langlassé 993* (holotype: G, G photo at F 27287, WIS; isotypes: B, GH, K, MEXU, P, P fragm. at WIS).

A rare endemic of arid scrublands in pockets of semideserts and summer-green deciduous forests inland from the Pacific coast in southwestern Mexico. The species name is somewhat misleading because the dendritic stellate pubescent on the underside of the leaves is velvety and soft, while only the upper leaf surface is scabrous.

3. Quadrella calciphila (Standl. & Steyerm.) Iltis & Cornejo, comb. nov. Basionym: *Capparis calciphila* Standl. & Steyerm., Field. Mus. Bot. 23:158. 1944. Type: GUATEMALA. Alta Verapaz: Cerro Chinajá, betw. finca Yalpemech & Chinajá, above source of Río San Diego, ca. 200 m, 1–2 Apr 1942 (fl), *J. Steyermark 45616* (holotype: F, F photo 51609 at WIS; isotypes: NY, US).

Capparis mayana Lundell, Wrightia 5:356. 1977, syn. nov. Type: Guatemala. Petén: La Cumbre in zapotal on top of hill, S of Río Pusila rd., ca. 3.5 km, 21 Mar 1977, *C.L. Lundell & E. Contreras 20630* (holotype: LL).

Quadrella calciphila is a very rare endemic, known by few collections from the tropical rain forests of Guatemala. It has a pubescence seemingly closely related to *Q. pringlei*, but mainly differs by having longer petals, 12–13 × 8–9 mm (vs. 4–6 × 3–5 mm), longer filaments, 8–10 mm (vs. 5–7 mm), and longer fruit, 9–15 cm (vs. 2.5–7 cm).

4. Quadrella dressleri Cornejo & Iltis, J. Bot. Res. Inst. Texas 4:77. 2010. Type: PANAMA. Panama: 8–12 km N of El Llano along new El Llano-Cartí rd., premontane wet forest, 400–450 m, 12 Dec 1973 (fl), *M. Nee, A. Gentry & R. Dressler 8765* (holotype: WIS; isotypes: MO, US, PMA, WIS [2]).

Restricted to wet or very wet, tropical rain or submontane cloud forests of the Caribbean slopes of eastern Panama, north of the continental divide and east of the Panama Canal, in the provinces of Colon, San Blas and Panama, at 50–500(–850) m (Cornejo & Iltis 2010).

5. Quadrella filipes (Donnell Smith) Iltis & Cornejo, comb. nov. Basionym: *Capparis filipes* Donnell Smith, Bot. Gaz. 23:2. 1897. Type: COSTA RICA. Limon: Suerre, Llanuras de Santa Clara, 300 m, Apr 1896, *D. J. Smith 6433* (lectotype, designated here: US).

Capparis clara Schery, Ann. Missouri Bot. Gard. 29:351. 1942, syn nov. Type: PANAMÁ. Bocas del Toro: Fish Creek Mts., 6 Apr 1941, *H. von Wedel 2235* (holotype: MO 1232846).

Quadrella filipes is uncommon but widespread from Costa Rica to Panama in tropical moist to wet forests. It differs from *Quadrella antonensis* mainly in its longer gynophores (22–42 vs. sessile to 4 mm), and the distichous leaves (vs. trash-collecting leaf funnels).

6. Quadrella indica (L.) Iltis & Cornejo, comb. nov. Basionym: *Breynia indica* L., nom. rej., Sp. Pl. 1:503. 1753. *Capparis breynia* L. Syst. Pl. ed. 10:1071. 1759, nom. illeg. *Quadrella breynia* (L.) J. Presl, Prir. Rostlin 2:261. 1825. *Pleuteron breynia* (L.) Raf., Sylva Tellur. 109. 1838. *Uterveria breynia* (L.) Bertoloni, Pl. nov. H. Bonon. 2:10. 1839. *Capparis indica* (L.) Druce, Bot. Exch. Club Soc. Brit. Isles 3:415. 1914. *Linnaeobreynia indica* (L.) Hutch., Gen. Fl. Pl. 2:311. 1967, nom. illeg. Type: "Habitat in Caribaeis & in continente vicina" (neotype, designated by Rankin & Greuter in Willdenowia 34:262. 2004, t. "Breynia *Eleaegni foliis Plum.*" in Breyne, 1739: t. ad p. 13).

Capparis amygdalina Lam., Encycl. 1:608. 1785. Type: ANTILLES: *J. Surian 123* (lectotype: P-JU, designated by Al-Shehbaz, in Flora of the Lesser Antilles-Dicotyledoneae 4(1):299. 1988).

Pseudocroton tinctorius Müller Argoviensis, Flora 55:24. 1872. Type: NICARAGUA: Near Managua, *E. Friedrichstahl 1072* (holotype: W; isotype: F)

Capparis tonduzii Briquet, Ann. Conserv. Jard. Bot. Genève 17:391. 1914. *Linnaeobreynia tonduzii* (Briquet) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: COSTA RICA. Forêts de Nicoya, Apr 1900, *A. Tonduz 13970* (holotype: G-DC, G-DC photo, F 008476).

Capparis furfuracea Ruiz & Pavón ex DC., Prodr. 1:252. 1824. *Capparis furfuracea* Sessé & Mociño, Fl. Mex. ed. 2, 129. 1894. *Quadrella furfuracea* (Ruiz & Pavón ex DC.) J. Presl, Prir. Rostlin 2:260. 1825. Type: PUERTO RICO: seashore near Ponce (fide McVaugh 2000: 116).

Quadrella indica is a common species, widespread from Pacific coastal western Mexico and Central America and from the Dominican Republic and Puerto Rico through the West Indies to Venezuela.

7. **Quadrella lindeniana** Cornejo & Iltis, J. Bot. Res. Inst. Texas 4:83. 2010. Type: MEXICO. Quintana Roo: Isla de Cozumel, a 1 km NO del Faro de la Punta Celarain, 4 Jun 1986 (fl), *E. Cabrera & H. de Cabrera 11433* (holotype: MEXU [MEXU photocopies at AAU, B, BM, COL, DAV, F, GH, GUAY, K, MA, NY, P, QCA, QCNE, S, U, UC, US, WIS]; isotypes: MO, TEX).

Quadrella lindeniana is restricted to Mexico's Yucatan Peninsula, where it occurs through dry thorn scrub to subdeciduous lowlands and subevergreen forests in the south, often growing on coastal dunes or rocky soils, and persisting in disturbed forests (Cornejo & Iltis 2010).

8. **Quadrella lundellii** (Standl.) Iltis & Cornejo, comb. nov. Basionym: *Capparis lundellii* Standl., Carnegie Inst. Wash. Publ. 461:57. 1935. Type: GUATEMALA. Petén: San Andrés, 3 May 1933 (fl), *C.L. Lundell 3115* (lectotype, designated here: F 706.401, F photo 51611; duplicate of the lectotype: US).

Capparis admirabilis Standl. in Yuncker, Field Mus. Nat. Hist., Bot. Ser. 9:291. 1940, syn. nov. *Linnaeobreynia admirabilis* (Standl.) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: HONDURAS. Yoro: in woodland in semi-arid region near Coyoles, 29 Jun 1938, *T.G. Yuncker, J.M. Koepper & K.A. Wagner 8130* (holotype: F, F photo 051607; isotypes: S, US).

Quadrella lundellii is a rare and local, in pockets of aridity near the coast, from southern Mexico to Guatemala. This species has the ability to produce stump sprouts and juvenile branches with strongly hastate leaves (ditto for species 10, *Q. morenoi*).

9. **Quadrella mirifica** (Standl.) Iltis & Cornejo, comb. nov. Basionym: *Capparis mirifica* Standl. in Woodson & Schery, Ann. Missouri Bot. Gard. 27:311. 1940. Type: PANAMA. Canal Zone: Vic. Salamanca Hydro. Station, Rio Pequeni, ca. 80 m, 28–29 Jul 1938 (fr), *R.E. Woodson, Jr., P.H. Allen & R.J. Seibert 1591* (holotype: F; isotypes: MO, NY).

Quadrella mirifica is a gorgeously golden, softly and velvety pubescent shrub, especially on the leaf margins, extremely rare and endemic to the tropical forests in the vicinity of the Canal Zone of Panama. It is similar in inflorescence structure by virtue of the elongate filiform peduncles of the pendulous umbels to the sometimes sympatric *Q. filipes*. Its stellate pubescence corresponds to that seen in two other species as *Q. steyermarkii* and *Q. asperifolia*.

10a. **Quadrella morenoi** Cornejo & Iltis, J. Bot. Res. Inst. Texas 4:86. 2010. Type: NICARAGUA. Boaco: km 7 carr. al Rama, 12°24'N 85°45'W, 180–200 m, 19 Jun 1982 (fr), *P. Moreno 16555* (holotype: WIS; isotypes: HNMN, MO, VDB).

Quadrella morenoi is scattered from southern Mexico (Michoacan) to southwestern Costa Rica, but is especially common in Central Nicaragua. It ranges from sea level to 930 m, in deciduous thorn scrub, gallery forests and semi-deciduous tropical dry forests and woodlands, persists in secondary vegetation and grazed areas, often on rocky and volcanic soils, and overlaps parapatrically the range of the similar but more common *Q. incana* (of subg. *Intutis*) from southern Mexico to Guatemala and rarely into central Honduras, mostly in the seasonally arid climates of the Pacific slope, with their sympatry apparently only at Tehuantepec in southern Oaxaca, Mexico (Cornejo & Iltis 2010).

10b. **Quadrella morenoi** f. **hastata** Iltis, J. Bot. Res. Inst. Texas 4:90. 2010. Type: NICARAGUA: Vic. Hac. San Jacinto, NE of Managua, stump sprouts from disturbed shrub and small tree savanna, ca. 100 m, 14 Oct 1991 (st), *H.H. Iltis & P. Anderson 30875* (holotype: WIS; isotypes: MO, NHNM, US).

A juvenile form characterized by the radically different, strongly hastate leaves, resembling those of *Q. lundellii* (Cornejo & Iltis 2010).

11. **Quadrella pringlei** (Briquet) Iltis & Cornejo, comb. nov. Basionym: *Capparis pringlei* Briquet, Ann. Conserv. & Jard. Bot. Genève 17:390. 1914. *Linnaeobreynia pringlei* (Briquet) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: MEXICO. Oaxaca: Tomellin Canyon, ca. 3000 ft, 18 May 1894 (fr), *C. Pringle 4639* (holotype: G; isotypes: B, B photo at WIS, BKL, BM, BR, CM, F, GH, GOET, IA, IA fragm. at WIS, K, LE, M, MEXU, MIN, MO, MSC, ND, NY, P, PR, UC, US, UT, UT fragm. & photo at WIS, VT, VT photos at WIS & XAL, Z).

Capparis langmaniae Standl. & L. Williams, Ceiba 14:5. 1968. TYPE: MÉXICO. CHIAPAS: betw. San Fernando & Plan de Ayala, barranca W of Tuxtla, "Chirimay de montaña," 17 Apr 1949 (fl, fr), *I.K. Langman 3912* (HOLOTYPE: EAP; ISOTYPES: F, US, US fragm. at WIS).

Quadrella pringlei is distributed from southern Mexico to Guatemala with disjunct local populations in Nicaragua (Sierra de Managua) and Costa Rica (below Monteverde). Due to the similar appareance, *Quadrella pringlei* is often confused with *Q. indica*, but has somewhat broader leaves, these ± spirally disposed on subverticillate petioles highly variable in length on the same branch. The flowers of *Q pringlei* are smaller and less attractive with shorter petals and stamens and with shorter, subsessile, fewer-seeded capsules.

12. Quadrella steyermarkii (Standl.) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis steyermarkii* Standl., Publ. Field Mus. Nat. Hist., Bot. Ser. 22:140. 1940. TYPE: GUATEMALA. IZABAL: Río Dulce, betw. Livingston & 6 mi. up river, on N side, near sea level, 14 Apr 1940 (fl), *J.A. Steyermark 39387* (HOLOTYPE: F, F photo 51613 at WIS]).

Quadrella steyermarkii is a rare Guatemalan rainforest endemic, similar in its obovate to obovate-elliptic leaf shape, but with shorter petals (7–8 × 3–5 mm vs. 12–13 × 8–9 mm) to the sympatric *Q. calciphila*, also in subg. *Breyniastrum*. *Quadrella steyermarkii* is exceedingly similar in leaf pubescence to *Quadrella mirifica*, but the pubescence is soft and velvety underneath, similar to that of *Q. asperifolia*.

III. Quadrella subg. **Intutis** (Raf.) Iltis, comb. et stat. nov. BASIONYM: *Intutis* Raf., Sylva Tellur. 108. 1838, p.p. (excl. *Capparis amygdalina* Lam., =*Quadrella indica*). TYPE: *Intutis ferruginea* (L.) Raf. (=*Quadrella ferruginea* [L.] Iltis & Cornejo) (NEOTYPE, designated here).

Capparis sect. *Pseudocrataeva* Grisebach, Fl. Brit. W.I., 17. 1864, p.p. (excl. *Capparis amygdalina* Lam., =*Quadrella indica*). TYPE: *Capparis ferruginea* L. (=*Quadrella ferruginea*) (lectotype, designated by Rankin & Greuter in Willdenowia 34:262. 2004).

Octanema Raf., Sylva Tellur. 112. 1838, p.p. (excl. *O. crotonoides* [=*Capparicordis crotonoides* (Kunth) Iltis & Cornejo], and *O. scabrida* [=*Colicodendron scabridum* (Kunth) Seeman]. TYPE: *Capparis angustifolia* Kunth (=*Quadrella angustifolia* [Kunth] Iltis & Cornejo) (LECTOTYPE, designated here).

Shrubs to small trees, stellate throughout, with small, subsessile, densely stellate to candelabroid leaves, small flowers with calyces with open aestivation, the sepals linear to triangular, far exceeded by the corolla in bud, or calyces with closed aestivation, the sepals oblong to lanceolate, covering the petals in bud nearly to anthesis; stamens usually 8, or ca. 16 (in *Q. singularis*); fruits ovoid to obovoid capsules, 1.5–3(–10 cm in *Q. angustifolia*), often tardily dehiscent, 1 to 6-seeded, with red pulp, splitting open with 2 to 4 recurved thin valves, exposing red arillate seeds dangling from funicles, the seeds with white or cream embryos. Whether the tissue around the seed is arillate in origin or part of the pulp or mesocarp is an unanswered question. In *Quadrella incana* it appears as if there is no pulp and the seed is enclosed by its own aril. This subgenus comprises 6 species, 6 subspecies and one variety.

When Hutchinson (1967) validated the genus *Quadrella*, he cited the Rafinesquean *Intutis* in synonymy and lectotypified both with *Quadrella cynophallophora*. However, similar to the lectotypification of *Quadrella* (op. cit.), Hutchinson's lectotypification of *Intutis* is not valid because *Quadrella cynophallophora* was not mentioned by Rafinesque in the protologue of *Intutis*, and is not original material for the name. *Capparis ferruginea* (=*Quadrella ferruginea*) is herein designated the neotype of *Intutis* because was the first syntype designed by Rafinesque in the protologue. Hutchinson (1967) placed *Quadrella ferruginea* within his heterogeneous *Linnaeobreynia* (=*Quadrella* subg. *Breyniastrum*), but *Q. ferruginea* is kept in *Quadrella* subgenus *Intutis* because the eight staments and seeds with white embryos.

Quadrella angustifolia, the first syntype cited by Rafinesque in the protologue of *Octanema*, is the herein designated lectotype of *Octanema* because of its flowers with eight stamens and seeds with a white embryo. *Quadrella angustifolia* and *Q. incana*, both species placed by Rafinesque in *Octanema* were included by Hutchinson (1967) within *Linnaeobreynia*.

Distribution.—*Quadrella* subgenus *Intutis* ranges from southern NorthAmerica (Texas) through Mexico to northern Honduras, and in the West Indies from Cuba to Hispaniola.

KEY TO THE SPECIES OF *QUADRELLA* SUBGENUS *INTUTIS*

1. Calyx with open aestivation, sepals triangular to linear, distinctively shorter than petals from buds.

2. West Indies species.
3. Branches and leaves, especially beneath, with a dense, ± rusty cover of stellate trichomes; sepals triangular, 1–2.5 mm, distinctively smaller to half of the petals length.
4. Leaf blades lanceolate; sepals linear-triangular; the common subspecies of Jamaica and Dominican Republic **Quadrella ferruginea** subsp. **ferruginea**
4. Leaf blades spathulate-lanceolate; sepals triangular; Cuba **Quadrella ferruginea** subsp. **cubensis**
3. Branches and leaves covered by yellowish white trichomes, the leaves beneath with a mixed tomentum of stellate and dendritic hairs; sepals linear, (2–)3–5(–6) mm, two third to as long as the petals.
5. Leaf blades above covered with soon deciduous sessile stellate trichomes, shaped like a sea-urchin or a stout bottlebrush, and with persistent, sharply pointed conical protuberances **Quadrella domingensis** subsp. **domingensis**
5. Leaf blades above initially dense, stellate, yellow, velvety pubescent, becoming glabrous, smooth and shiny, sharply pointed conical protuberances on the leaf blades absent **Quadrella domingensis** subsp. **grisebachii**
2. Continental species, from southeastern Texas, south to Guatemala and rarely into northern Honduras.
6. Sepals linear to filiform, 2–5 × 0.5–0.9 mm; staminal filaments 6–9 mm.
7. Leaf blades lanceolate or narrowly elliptic to oblanceolate or obovate **Quadrella incana** subsp. **incana**
7. Leaf blades broadly obovate to rhomboid; mostly in Yucatan but scattered across the range of the species **Quadrella incana** subsp. **yucatanensis**
6. Sepals triangular, 1–1.5 × 1–1.3 mm; staminal filaments ca. 4 mm; Mexico, in western Jalisco **Quadrella incana** var. **triangularis**
1. Calyx with closed aestivation, sepals oblong, covering the petals in bud nearly to anthesis.
8. Leaf blades narrowly oblong to oblong-lanceolate; petioles 1–5 mm; calyx valvate-reduplicate in flowerbud; southern Mexico **Quadrella angustifolia**
8. Leaf blades ovate to elliptic or slightly obovate; petioles 6–15 mm; calyx valvate but not reduplicate in flowerbud; West Indies.
9. Stamens 8, filaments ca. 8 mm; gynophores 6–9 mm; Dominican Republic **Quadrella alaineana**
9. Stamens ca. 16, filaments 12–14 mm; gynophores 12–18 mm; eastern Cuba **Quadrella singularis**

1. Quadrella alaineana Cornejo & Iltis, J. Bot. Res. Inst. Texas 4:75. 2010. TYPE: DOMINICAN REPUBLIC [Hisp.]. Azua: Monte Río Azua, sandy soil, in thickets, 22 Aug 1964 (fl), *Bro. Basilio Augusto Lavastre 1730* (HOLOTYPE: JBSD; ISOTYPES: NY, WIS).

Endemic to the Dominican Republic (Cornejo & Iltis 2010).

2. Quadrella angustifolia (Kunth) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis angustifolia* Kunth, Nov. Gen. Sp. Pl. 5:46 t. 438. 1821. *Octanema angustifolia* (Kunth) Raf., Sylva Tellur. 112. 1838. *Colicodendron angustifolium* (Kunth) Hutch., Gen. Fl. Pl. 2:309. 1967. TYPE: MEXICO: "Crescit in Cañada de Sopilote, inter Mexico at Acapulco," Apr, *A. Humboldt & A. Bonpland s.n.* (LECTOTYPE, designated here, P).

Quadrella angustifolia is a rare, highly local endemic in two super arid desert pockets inland from the Pacific coast in the southern Mexican states of Michoacan and Guerrero. This species has xerophyllous, linear leaves and thick-walled, often tardily dehiscent siliquiform capsules, the latter a condition which induced Eichler (1865) to place it in *Capparis* subg. *Colicodendron*. The species is placed in *Quadrella* because of its calyx with closed reduplicate valvate aestivation and eight stamens. The capsules are similar to those of *Q. asperifolia* and *Q. indica* in subg. *Breyniastrum*, which suggests that our classification of *Quadrella* is somewhat arbitrary. Molecular biology is needed to understand the true relationships.

3. Quadrella domingensis (Spreng. ex DC.) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis domingensis* Spreng. ex DC. Prodr. 1:253. 1824. TYPE: Dominican Republic. Hispaniola: Santo Domingo, Azua, s.d., *C. Bertero s.n.* (HOLOTYPE: G-DC, ISOTYPES: BM, M).

3a. Quadrella domingensis (Spreng. ex DC.) Iltis & Cornejo subsp. **domingensis**

Quadrella domingensis subsp. *domingensis* is a local taxon on Hispaniola, with the type collection (fide Urban 1920–21) from Azua, Santo Domingo. It is characterized by having persistent, sharply pointed conical protuberances above the leaf blades (Rankin & Greuter 2004).

3b. Quadrella domingensis subsp. **grisebachii** (Eichler) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis grisebachii*

Eichler in Martius, Fl. Bras. 13:275. 1865. *Linnaeobreynia grisebachii* (Eichler) Hutch., Gen. Fl. Pl. 2:310. 1967. *Capparis domingensis* subsp. *grisebachii* (Eichler) R. Rankin in R. Rankin & Greuter, Willdenowia 34:263. 2004. Type: CUBA: "In Cuba Orientali," 1856–1857, *C. Wright 9b* (Holotype: G, G fragm. at WIS; Isotypes: BR, BR photo at WIS, GH p.p. [with *C. Wright 1869*], K, K photo at WIS).

Quadrella domingensis subsp. *grisebachii* is a local subspecies of Cuba and Hispaniola. It is characterized by having a dense but more brightly yellow pubescence than *Q. domingensis* subsp. *domingensis*, and mainly by the absence of the persistent, sharply pointed conical protuberances above the leaf blades (Rankin & Greuter 2004).

4. Quadrella ferruginea (L.) Iltis & Cornejo, comb. nov. Basionym: *Capparis ferruginea* L., Syst. Nat., ed. 10, 1071. 1759. *Linnaeobreynia ferruginea* (L.) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: JAMAICA: *P. Browne s.n.* (Lectotype, designated by Rankin & Greuter in Willdenowia 34:263. 2004; 664.6 [LINN]).

Capparis octandra Jacq., Select Stirp. Amer. Hist. 160 t. 100. 1763. Type: HISPANIOLA: "Habitat in Domingo ad Portum Principis in fruticosis maritimis" (lectotype, designated by Rankin & Greuter in Willdenowia 34:263. 2004; t. 100 in Jacquin 1763).

Capparis comosa Jacq., Select Stirp. Amer. Hist. 160. 1763. *Pleuteron comosa* (Jacq.) Raf., Sylva Tellur. 109. 1838. *Uterveria comosa* (Jacq.) Bertoloni, Pl. nov. H. Bonon. 2:9. 1839. Type: HISPANIOLA. Santo Domingo: "Habitat passin in inundatis maritimis Jaquesi in Domingo" (Lectotype, not designated).

4a. Quadrella ferruginea (L.) Iltis & Cornejo subsp. **ferruginea**

Quadrella ferruginea subsp. *ferruginea* is a common subspecies of Jamaica The lanceolate leaf blades and linear-triangular sepals characterize this susbpecies (Rankin & Greuter 2004).

4b. Quadrella ferruginea subsp. **cubensis** (R. Rankin) Iltis & Cornejo, comb. nov. Basionym: *Capparis ferruginea* L. subsp. *cubensis* R. Rankin, Willdenowia 34:263, 2004. Type: CUBA. Camagüey: "Nuevitas, falda sur de la Península Pastelillo," 11 May 1976, *Areces et al. HFC 31382* (Holotype: HAJB; Isotypes: B, JE).

Quadrella ferruginea subsp. *cubensis* is a local endemic of eastern Cuba. It is characterized by the spathulate-lanceolate leaf blades and triangular sepals (Rankin & Greuter 2004: 274).

5. Quadrella incana (Kunth) Iltis & Cornejo, Novon 17:452. 2007. Basionym: *Capparis incana* Kunth, Nov. Gen. & Sp. 5:94. 1821. *Octanema incana* (Kunth) Raf., Sylva Tellur. 112. 1838. *Linnaeobreynia incana* (Kunth) Hutch., Gen. Fl. Pl. 2:310. 1967. Type: MEXICO. Guerrero: "Crescit in declivitate occidentali montium Mexicanorum, inter Mescala et Estola, 300 m," Apr, *A. Humboldt & A. Bonpland s.n.* (Lectotype: P, designated in Iltis & Cornejo 2007a; Isotype: B–W 10,045, B–W photo 9479 at WIS).

Capparis karwinskiana Schlechter, Linnaea 10:237. 1836. Type: MEXICO: San Bartolo, 1830, *W.F. Karwinski s.n.* (Holotype: M; Isotype: BR, BR photo at WIS).

Quadrella incana is the only species of subg. *Intutis* in the Mesoamerican flora. Except for its variable leaf shape, *Quadrella incana* is a rather uniform species as for flowers and fruits. It can be identified by its white cream cochleate-reniform embryo surrounded by a hard brittle testa, the leaves with fewer (3 to 8) lateral veins and the rusty stellate pubescence of the young buds.

5a. Quadrella incana (Kunth) Iltis & Cornejo subsp. **incana**

Quadrella incana subsp. *incana* is widespread from Texas, eastern and southwestern Mexico to Guatemala (*Contreras 11084*) and barely into Honduras (*Molina & Molina 26028*) (Iltis & Cornejo 2007a).

5b. Quadrella incana var. **triangularis** Cornejo & Iltis, J. Bot. Res. Ins. Texas 4:80. 2010. Type: MEXICO. Jalisco: ca. 8 km NW of Chamela, 19°33'N 105°08'W, 2 m, 22 Jun 1984, *H.H. Iltis & S. Wisniewski 29194* (Holotype: WIS; Isotype: MEXU).

Quadrella incana var. *triangularis* is known by only two collections from Chamela (Mexico, Jalisco). The distinctive smaller (1–1.5 × 1–1.3), triangular sepals and smaller filaments (ca. 4 mm), characterize this variety (Cornejo & Iltis 2010).

5c. Quadrella incana subsp. **yucatanensis** (Lundell) Iltis, J. Bot. Res. Ins. Texas 4:83. 2010. Basionym: *Capparis yucatanensis* Lundell, Bull. Torrey Bot. Club 69:389. 1942. Type: MEXICO [Yucatán]: Chichen Itzá, off Kaua road, 8 Jun 1938 (fr), *C. Lundell & A. Lundell 7452* (Holotype: MICH; Isotypes: DS, F [not seen], GH, LL-TEX [2], NY, US]).

Quadrella incana subsp. *yucatanensis* is most commonly represented in specimens from the Yucatan Peninsula, but scattered beyond, throughout much of the range of *Q. incana*. It is characterized by its broadly obovate to rhomboid leaves.

6. Quadrella singularis (R. Rankin) Iltis & Cornejo, comb. nov. BASIONYM: *Capparis singularis* R. Rankin, Willdenowia 34:263. 2004. TYPE: CUBA. GUANTÁNAMO: U.S. Naval Base, Guantánamo Bay, windward side, Cuzco Beach, 19°58'23.4"N 75°08'45.1"W, 3 Dec 1996, *Areces et al. 6496* (HOLOTYPE: MNHN; ISOTYPE: MAPR).

Quadrella singularis is a rare endemic of eastern Cuba, known only from the type specimen. Although the flower buds of *Quadrella singularis* are unknown, this species is placed in *Quadrella* subg. *Intutis* because the stellate pubescence. The similar length of its sepals and petals (7 and 7 to 8 mm, respectively), suggest that "the sepals appear to tend to the valvate condition" (Rankin & Greuter 2004).

REJECTED NAMES

Quadrella crotonoides (Kunth) J. Presl, in Berchtold & J. Presl, Prir. Rostlin 2:260. 1825 (= *Capparicordis crotonoides* [Kunth] Iltis & Cornejo).

Quadrella sidaefolia (Ruiz & Pavon ex DC.) J. Presl, in Berchtold & J. Presl, Prir. Rostlin 2:260. 1825 (= *Capparicordis crotonoides* [Kunth] Iltis & Cornejo).

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TEN NEW MYRTACEAE FROM EASTERN AND NORTHEASTERN BRAZIL

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ABSTRACT

Ten new species of Myrtaceae from the eastern and northeastern Brazilian states of Bahia, Espírito Santo, Minas Gerais and Rio Grande do Norte are described, illustrated, compared to the related species, and have their conservation status evaluated: *Eugenia azeda* (from Rio Grande do Norte), *Eugenia valsuganana*, and *Myrcia crassa*, (both from Espírito Santo), *Myrcia floridissima* (from Minas Gerais), *Myrcia mucugensis*, *M. pendula*, *Myrcia pseudomarlierea*, *Myrcia pseudospectabilis* and *Myrcia tetraphylla* (all from Bahia) and *Plinia espinhacensis* (from Minas Gerais).

Key Words: Myrtaceae, Brazil, taxonomy, *Eugenia*, *Myrcia*, *Plinia*

RESUMO

Onze novas espécies de Myrtaceae do nordeste e sudeste do Brasil, dos estados da Bahia, Espírito Santo, Minas Gerais e Rio Grande do Norte são descritas, ilustradas, comparadas com as espécies próximas e avaliadas quanto a sua situação de conservação: *Eugenia azeda* (do Rio Grande do Norte), *Eugenia valsuganana* e *Myrcia crassa*, (ambas do Espírito Santo), *Myrcia floridissima* (de Minas Gerais), *Myrcia mucugensis*, *M. pendula*, *Myrcia pseudomarlierea*, *Myrcia pseudospectabilis* e *Myrcia tetraphylla* (todas da Bahia) e *Plinia espinhacensis* (de Minas Gerais).

Palavras chave: Myrtaceae, Brasil, taxonomia, *Eugenia*, *Myrcia*, *Plinia*

The family Myrtaceae is represented in Brazil by about 1000 species (Landrum & Kawasaki 1997:508). Species of the family occur in all vegetation types in Brazil, but they seem to be especially frequent in the coastal rainforest (Floresta Atlântica) that ranges from northeastern to southern Brazil, as was recorded in some inventories (e.g., Mori et al. 1983; Lima & Guedes-Bruni 1997; Thomaz & Monteiro 1997). During the examination of exsiccates kept at some Brazilian herbaria, I had the opportunity of studying some species, mainly from the Atlantic Forest domain, that I consider here as undescribed.

1. **Eugenia** L.

Eugenia is characterized mostly by the presence of tetramerous flowers with two locules and several ovules per locule and seeds with completely fused cotyledons without any visible hypocotyl. The genus is pantropical, and presents about 350 species in Brazil (Landrum & Kawasaki 1997).

1.1. Eugenia azeda Sobral, sp. nov. (**Figs. 1–3**). Type: BRAZIL. Rio Grande do Norte: Parnamirim, CATRE-Ministério da Aeronáutica, 5°54'30"S, 35°13'30"W, 15 Dec 1999, *L.A. Cestaro 99-0259* (holotype: BHCB; isotype: UFRN).

Species *Eugeniae ligustrinae* foliis subsessilibus fructis majoribus recedit.

Shrub to small tree 2–9 m. Twigs terete, gray when dry, the most distal ones to 1 mm in diameter, glabrous or very minutely strigose with simple erect trichomes to 0.1 mm, falling off in longitudinal stripes; internodes 7–20 mm. Leaves subsessile, with petioles 1–2 × 1.5 mm, frequently evident only when the leaf is viewed abaxially; blades elliptic to ovate-elliptic, 20–50 × 10–22 mm, discoloured when dry, the abaxial face paler; glandular dots smaller than 0.1 mm in diameter, 10–30 per square milimeter, ocasionally evident adaxially but clearly visible and darker than the surface abaxially; apex obtuse or rounded, sometimes widely acute; base obtuse to rounded, sometimes very slightly auriculate; midvein sulcate adaxially and prominent abaxially; lateral veins 6–8 pairs, markedly prominent adaxially and faintly so abaxially, leaving the midvein at angles of about 45 degrees; marginal vein to 1 mm from the revolute margin. Inflorescences terminal, with two

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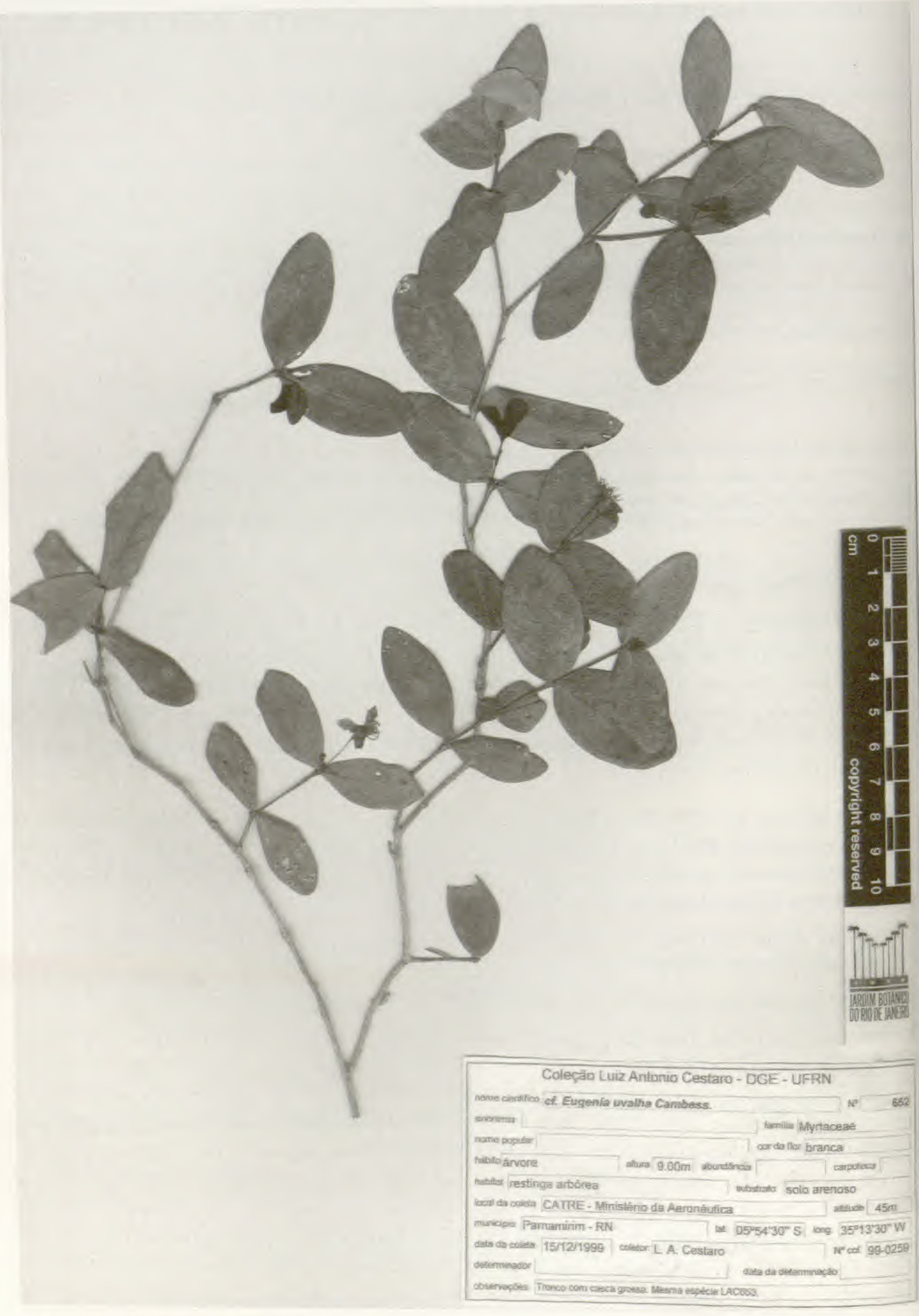
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JARDIM BOTANICO DO RIO DE JANEIRO

Coleção Luiz Antonio Cestaro - DGE - UFRN

nome científico *cf. Eugenia uvalha Cambess.* Nº 652

sinonimia familia Myrtaceae

nome popular cor da flor branca

hábito árvore altura 9.00m abundância carpoteca

habitat restinga arbórea substrato solo arenoso

local da coleta CATRE - Ministério da Aeronáutica altitude 45m

municipio Parnamirim - RN lat. 05°54'30" S long. 35°13'30" W

data da coleta 15/12/1999 coletor L. A. Cestaro Nº col. 99-0259

determinador data da determinação

observações Tronco com casca grossa. Mesma espécie LAC653.

Fig. 1. *Eugenia azeda* - image of holotype.

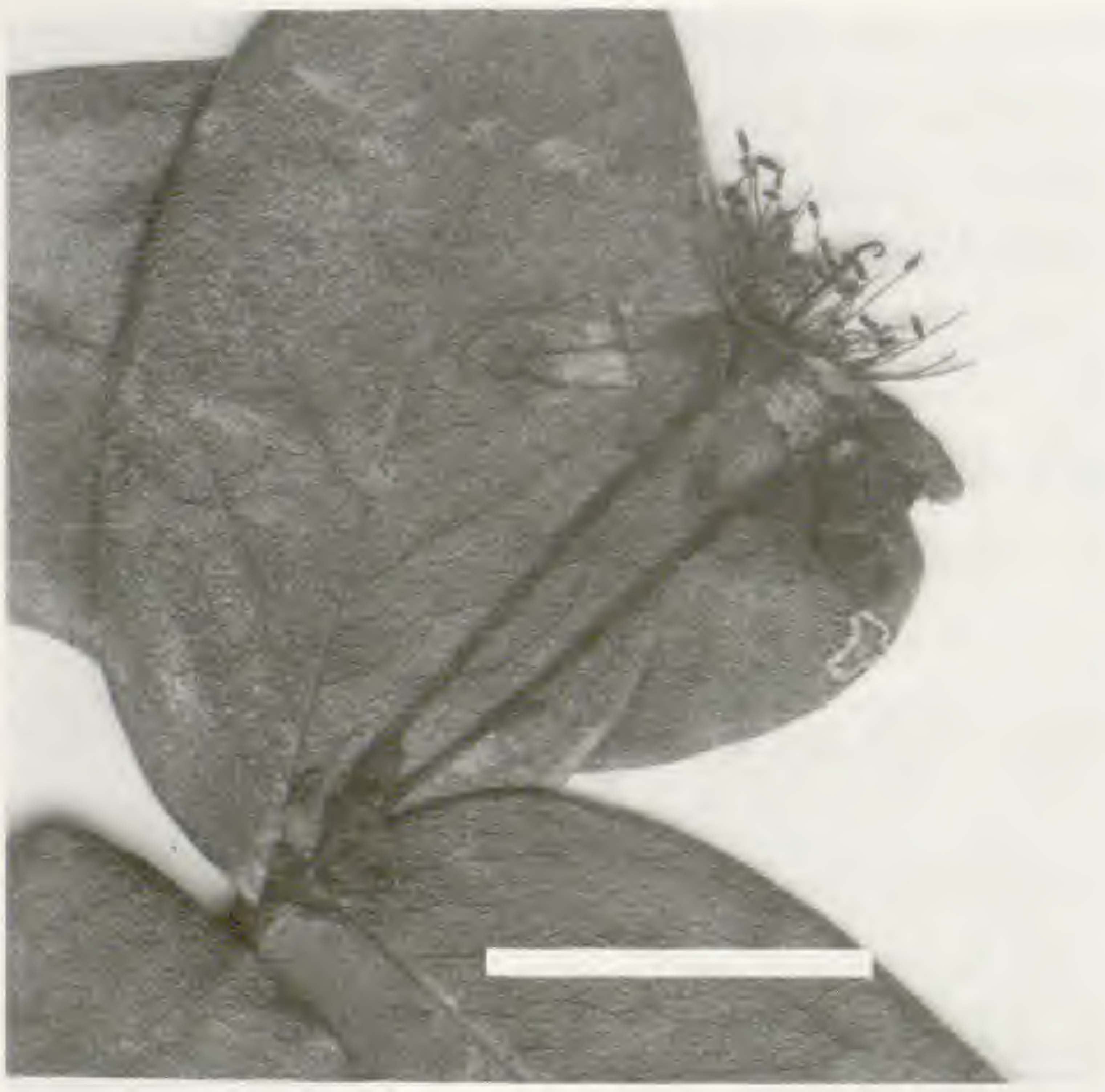


Fig. 2. *Eugenia azeda* - detail of flowers (scale: 10 mm).

flowers on an auxotelic axis 1–4 × 0.4–0.8 mm that produces adult leaves after anthesis; bracts at the base of the axis lanceolate-obovate, 4 × 0.8–1 mm; pedicels 8–25 × 0.2–0.3 mm, with simple erect trichomes to 0.1 mm; bracteoles missing, probably deciduous before anthesis; flower buds obovate, glabrous, to 5 × 4 mm, the ovary markedly distinct from the calyx; calyx lobes four, oblong-lanceolate, 5–6 × 2 mm, concave, glabrous but sometimes with cilia to 0.2 mm at the apex, strongly reflexed and concealing the ovary at anthesis; petals obovate, glabrous, white, to 8 × 5 mm; stamens about 50, 5–6 mm, the anthers elliptic, to 0.6 × 0.3 mm, eglandular; staminal ring to 3 mm in diameter, occasionally with scattered trichomes to 0.2 mm; style 4–6 mm, the stigma punctiform, minutely papillose; calyx tube absent; ovary with two locules and 6 ovules per locule. Fruits globose, yellow when ripe, to 30 mm

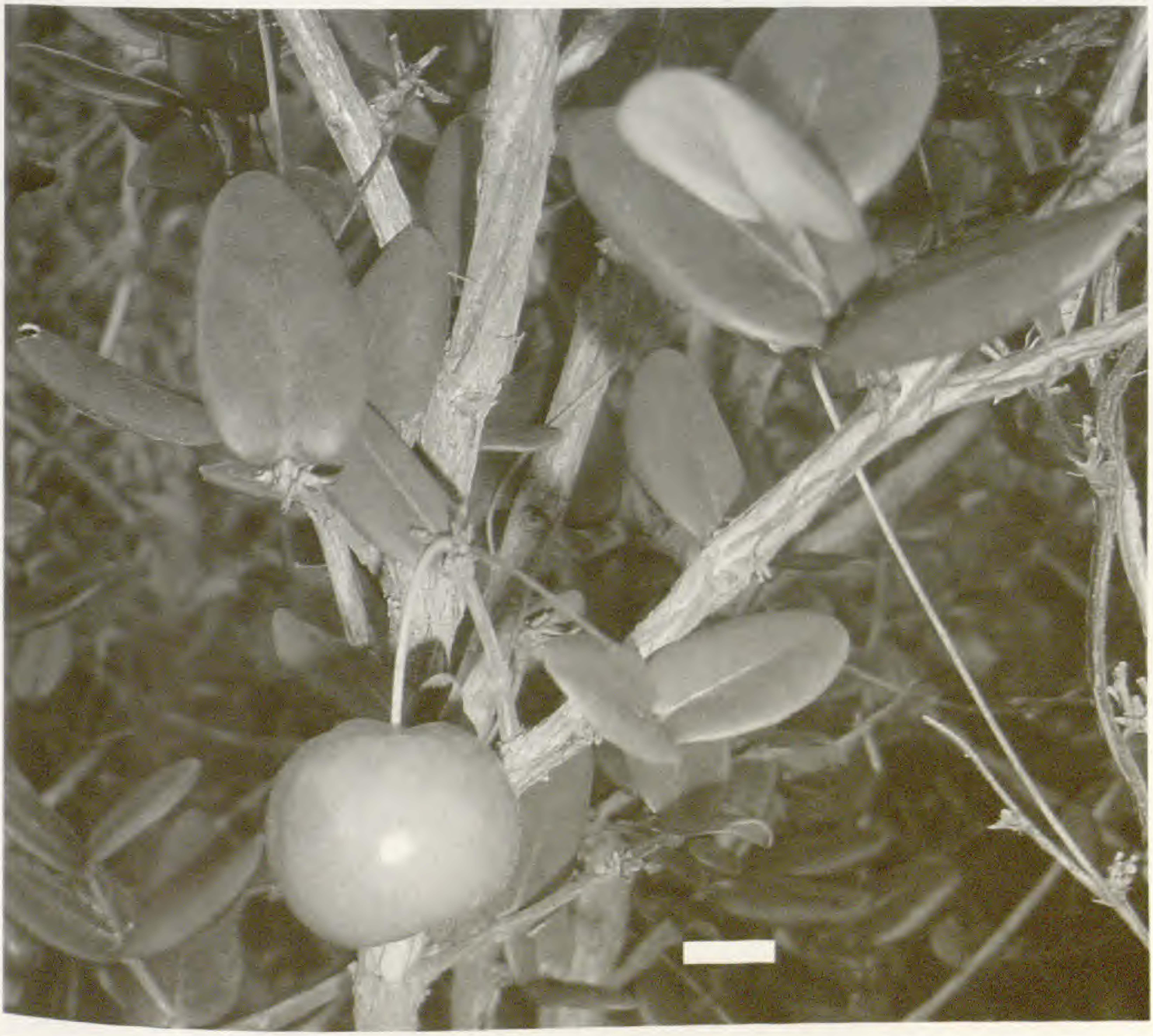


Fig. 3. *Eugenia azeda* - mature fruits (*Sobral & Cestaro 10888*; scale: 10 mm).

in diameter when fresh, about 20 mm when dry, with one seed, this slightly reniform, to 10 × 8 mm, with a gray, easily detachable testa and embryo with fused cotyledons and hypocotyl not visible.

Habitat, distribution and phenology.—This species is a shrub or small tree from coastal forests (restingas and seasonally deciduous forests) of the municipalities of Natal and Parnamirim, at the northeastern state of Rio Grande do Norte, growing at altitudes near the sea level. Flowers were collected in November and December, and fruits in December and February.

Conservation.—According to IUCN criteria (IUCN 2001), *Eugenia azeda* can be considered as endangered (EN), fitting criteria B1 ab(iii): its presently known area of occurrence is smaller than 5000 km2 (criterion B1) and its habitat is a severely fragmented one (criterion a) which presents a continuing decline in extension (criterion b(iii)), since Natal, the capital of the state of Rio Grande do Norte, and neughbouring municipalities are under intense urban pressure.

Affinities.—This species is close to *Eugenia ligustrina* (Sw.) Willd. (for description see Berg, 1857–1859:343), from which it is set apart by the following characters:

1. Blades cuneate at base, with evident petioles to 4 mm; fruits smaller than 10 mm in diameter, red when ripe; widespread from Antilles to southeastern Brazil. ____ **Eugenia ligustrina**
1. Blades rounded at base, subsessile, the petioles to 2 mm and not evident when viewed from above; fruits to 30 mm in diameter, yellow when ripe; local in Rio Grande do Norte, northeastern Brazil. ____ **Eugenia azeda**

Etymology.—The epithet is derived from the local name for the species, "ubaia-azeda." The vernacular name "ubaia" or "uvaia" is used in Brazil for several species of *Eugenia* with edible fruits, the most widely known being *Eugenia pyriformis* Cambess. (Sobral 2003), and "azeda" is the Portuguese word for "bitter"—the fruits are widely appreciated locally for their bitter taste.

PARATYPES: **BRAZIL. Rio Grande do Norte, mun.:** Natal, 8 Nov 1951, *Alvarenga 32* (BHCB, RB); 26 Feb 2001, *Cestaro s.n.* (BHCB); 10 Dec 2006, *Sobral & Cestaro 10887* (BHCB, BRIT, MBM); 10 Dec 2006, *Sobral & Cestaro 10888* (BHCB, BRIT, K, MBM, RB).

1.2. **Eugenia valsuganana** Sobral, sp. nov. (**Fig. 4**).

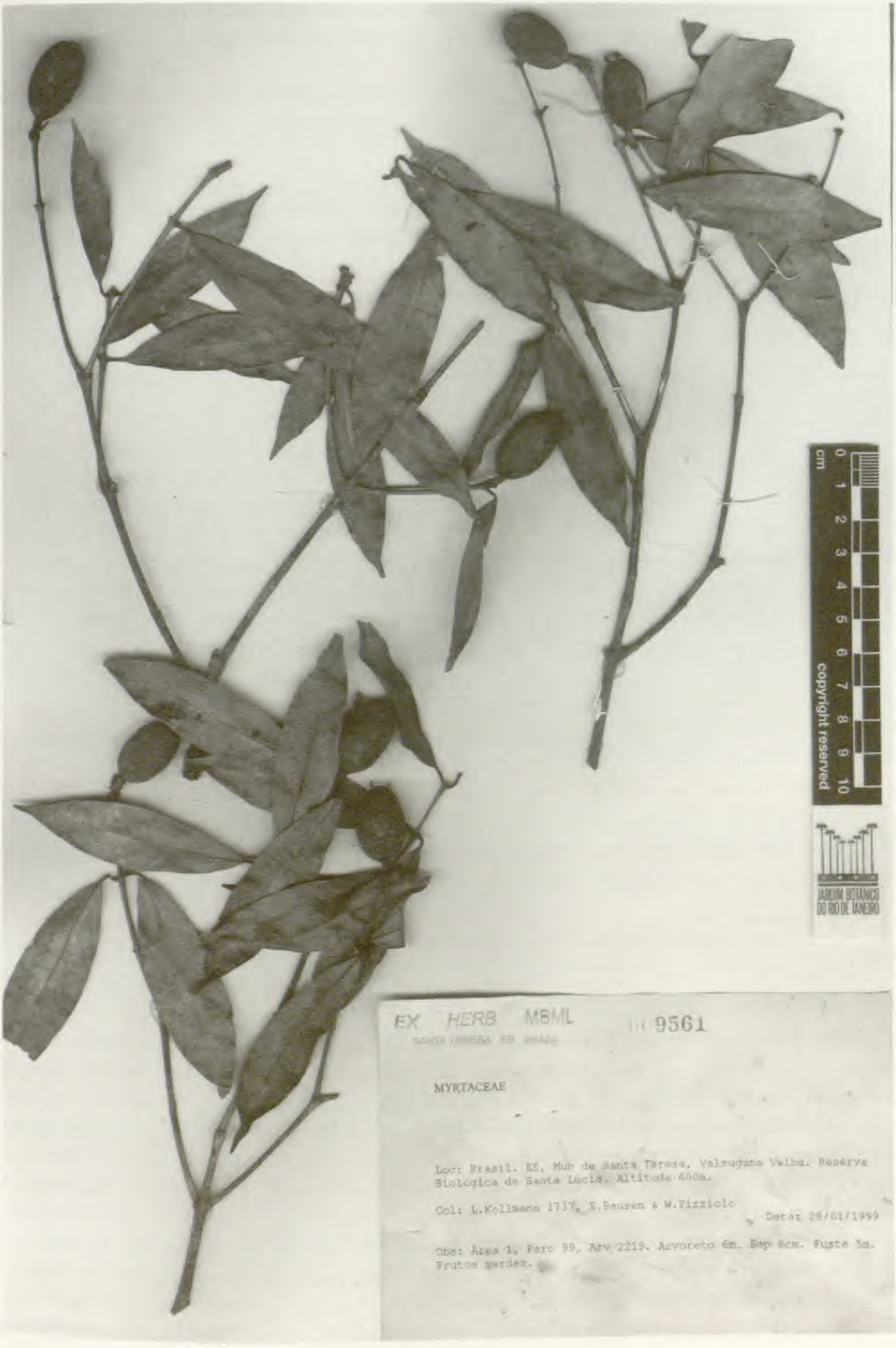
TYPE: BRAZIL. ESPÍRITO SANTO, MUN.: Santa Teresa, Valsugana Velha, Reserva Biológica de Santa Lúcia, 28 Jan 1999, *L. Kollmann, E. Bausen & W. Pizziolo 1737* (HOLOTYPE: MBML; ISOTYPES: BHCB, BRIT).

Species *Eugeniae plicatocostatis* proxima, a qua foliis angustatis, nervo medio supra prominentis et floris lobis calycinis glabris recedit.

Tree 4–7 m. Plants glabrous, except for gray trichomes to 0.1 mm on the ovaries. Twigs gray, complanate, to 2 mm in diameter, the internodes 15–20 mm. Leaves with petioles 6–8 × 1–1,7 mm, drying black; blades lanceolate to lanceolate-oblong, 90–140 × 25–40 mm, pale light green and concolored when dry, with 10–15 glandular dots per square milimeter, these smaller than 0.1 mm in diameter and easily visible on both sides; apex acute or acuminate to 10 mm; base cuneate; midvein prominent on both sides, more evidently so abaxially; lateral veins 10–14 pairs, prominent on both sides, leaving the midvein at angles 70–80 degrees; marginal veins two, 4–5 mm and 0.5–1 mm from the margin, the margin itself revolute. Inflorescences axillary, fasciculiform, with 4–8 flowers crowded in an axis to 3 × 2 mm; pedicels absent or occasionally developed in fruits, then to 2 × 1 mm; bracteoles widely triangular, to 1.5 × 1–1.5 mm, densely covered by convex glands to 0.1 mm in diameter, flower buds to 3 × 2 mm, the ovary densely pilose and clearly distinct from the glabrous calyx lobes, these rounded, glabrous, to 2 × 2 mm, with glands as on the bracteoles; petals rounded, to 2 × 2 mm in buds; stamens about 60, to 2 mm in bud, the staminal ring to 1.5 mm in diameter; style to 2.5 mm in bud; ovary with two locules and 6 ovules per locule. Fruits elliptic, 20–26 × 16–20 mm, yellow when ripe, glabrous, crowned by calyx lobes to 3 × 3 mm, with one seed, this elliptic, to 22 × 12 mm, with an easily detachable chartaceous, gray testa and embryo with two fused, indistinguishable cotyledons and no evident hypocotyl.

Habitat, distribution and phenology.—This species is a small tree from montane forests, growing at altitudes of about 600 m above sea level. It is presently known only from the municipality of Santa Teresa, in the eastern Brazilian state of Espírito Sante. Flowers were collected in October and fruits in January.

Conservation.—According to IUCN criteria (IUCN 2001), *Eugenia valsuganana* can be considered as endangered, fitting criteria B1 ab(iii): its known area of occurrence is smaller than 5000 km2 (criterium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EX HERB MBML 9561

MYRTACEAE

Loc: Brasil. ES, Mun de Santa Teresa, Valsugana Velha. Reserva Biologica de Santa Lúcia. Altitude 600m.

Col: L.Kollmann 1737, E.Bausen & W.Pizziolo

Data: 28/01/1999

Obs: Área 1, Parc 99, Arv 2219. Arvoreto 6m. Dap 8cm. Fuste 5m. Frutos verdes.

Fig. 4. *Eugenia valsuganana* - image of isotype at BHCB.

B1), it grows in a severely fragmented habitat (criterium a) that presents a continuing decline in extension (criterium b(iii)), since only 18% of the area of Santa Teresa still retains its original vegetation (Mendes & Padovan 2000:16).

Affinities.—This species is apparently close to *Eugenia plicatocostata* O.Berg (for description see Berg 1857–1859:575), a species collected in coastal Bahia and Espírito Santo, from which it can be distinguished by the following characters:

1. Blades light brown when dry, to 130 × 60 mm, the ratio length/width about 2:1; midvein adaxially sulcate; flowers without sharp contrast between ovary and calyx lobes, both equally pilose **Eugenia plicatocostata**
1. Blades pale light green when dry, to 140 × 40 mm, the ratio length/width 3–3.5:1; midvein adaxially prominent or biconvex; flowers with ovary pilose and calyx lobes glabrous **Eugenia valsuganana**

Etymology.—Alludes to the locality of the type collection.

PARATYPE. **BRAZIL. Espírito Santo, Mun.:** Santa Teresa, Oct 2005, *Britto 117* (MBML).

2. **Myrcia** DC. ex Guillaumin

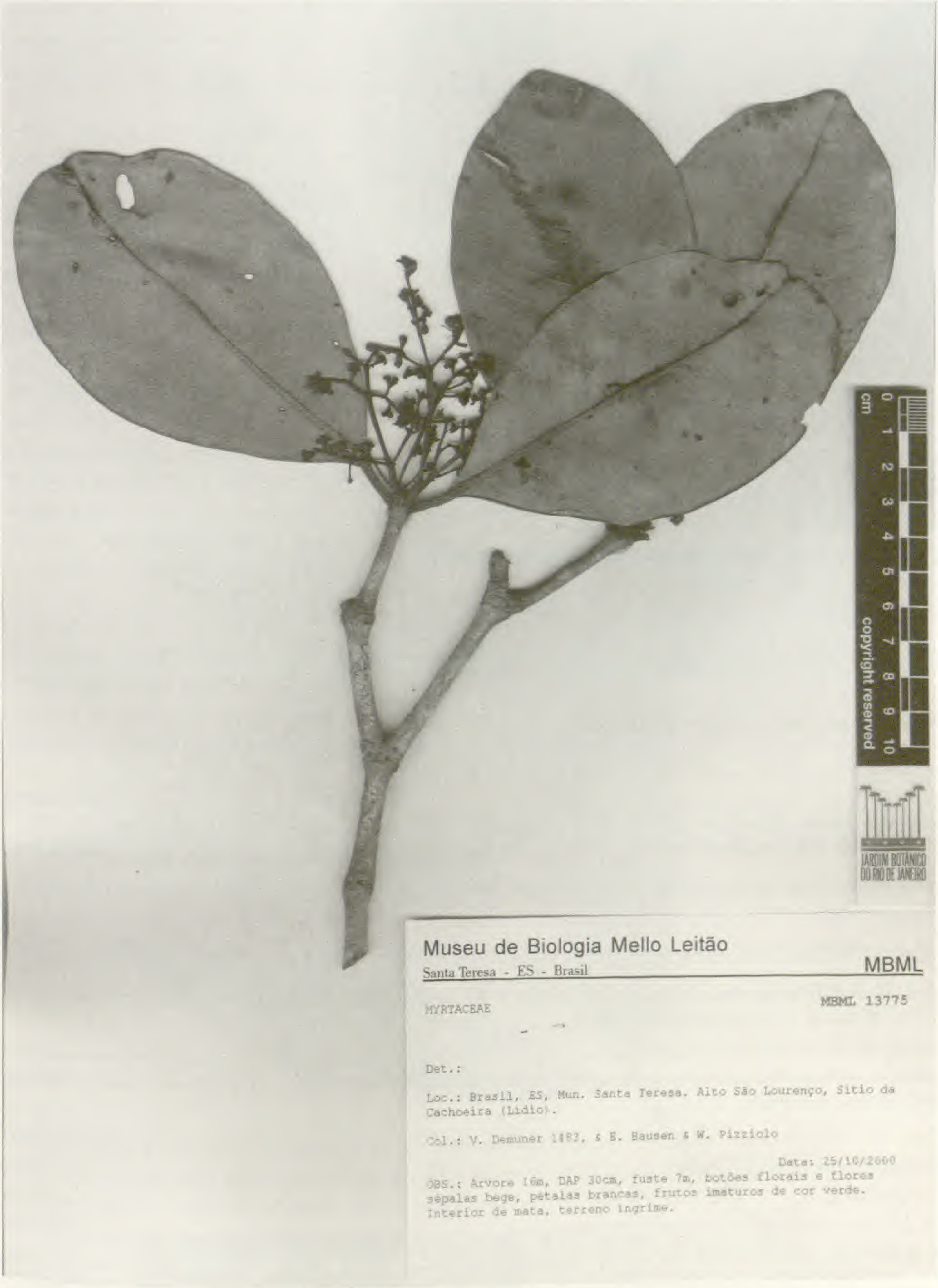
Myrcia is an American genus with about 400 species, characterized by mostly paniculiform inflorescences, pentamerous flowers with bi- or trilocular ovaries with two ovules per locule and embryos with well-developed hypocotyl and cotyledons (Landrum & Kawasaki 1997). It is one of the four genera of subtribe Myrciinae as provisionally accepted by Lucas et al. (2007)—*Calyptranthes* Sw., *Gomidesia* O.Berg, *Marlierea* Cambess. and *Myrcia*. The separation between these genera relied mostly in calyx characters: *Calyptranthes* and *Marlierea* present fused calyx lobes (opening through a calyptra in the first genus and tearing in lobes in the second) and *Myrcia* and *Gomidesia* free calyx lobes (*Gomidesia* being distinguished from *Myrcia* through its sinuose opening of the anthers). Such characters are feasible, and indeed the results of Lucas et al. point to this assemblage as more phylogenetically close than was thought before, since in her cladograms there is no consistent separation of these genera. So, I have decided here to take *Myrcia* in a wider circumscription, naming under it three species that might also be included under *Marlierea* (*Myrcia crassa*, *Myrcia mucugensis* and *Myrcia pseudomarlierea*). Indeed Kawasaki & Holst (1994:141) made a similar decision when they described *Myrcia rupta*, a species that otherwise would be assigned to *Marlierea*.

It is worth noting that among these genera *Calyptranthes* has nomenclatural priority over Myrcia and the others (McVaugh 1956). Moving all species of *Myrcia* to *Calyptranthes* would be quite undesirable as was adequately pointed by McVaugh (1968), so, it is convenient to consider the possibility of proposing the conservation of *Myrcia* over *Calyptranthes*.

2.1. Myrcia crassa Sobral, sp. nov. (**Figs. 5–6**). TYPE: BRAZIL. ESPÍRITO SANTO, MUN.: Santa Teresa, 25 Oct 2000, *V. Demuner, E. Bausen & W. Pizziolo 1483* (HOLOTYPE: MBML; ISOTYPE: BHCB).

Species *Marliereae silvaticae* proxima, a qua ramis crassis glabrisque, foliis glabris, inflorescentiis glabris pluriflorisque et floribus minoribus recedit.

Small tree 1.5 m to tree 18 m. Twigs glabrous, to 2–5 mm in diameter, subterete; internodes to 60 mm. Leaves with petioles 8–20 × 2,2–3,2 mm; blades obovate, elliptic or ovate-elliptic, 100–200 × 60–110 mm, stiff, discoloured when dry; glands from 0.05 to 0.1 mm in diameter, about 10 per square milimeter, sometimes visible adaxially but more easily observed against light; apex widely acute to obtuse, sometimes abruptly acuminate to 10 mm; base cuneate or obtuse; midvein sulcate adaxially and prominent abaxially; lateral veins 15–20 pairs, prominent on both sides, leaving the midvein at angles 60–70 degrees; marginal veins two, 2–3 mm and 0.5 mm from the margin. Inflorescences paniculiform, with 30–60 flowers and two to three levels of ramification, the first branch occasionally with two contiguous ramifications, the axis 40–120 × 2–4 mm; flowers sessile, densely covered with brown simple appressed trichomes to 0.1 mm; bracteoles ovate-lanceolate, 1–1,5 × 0,8–1 mm; flower buds obovate, 3–3,5 × 2 mm, with four rounded lobes visible at the apex, at anthesis tearing the calyx tube somewhat irregularly, 1,2–1,5 × 1,5–2 mm; petals two to three, rounded, 2–3 × 2–3 mm; stamens 60–70, 3–4 mm, the anthers elliptic, to 0.5 × 0.3, eglandular; staminal ring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Museu de Biologia Mello Leitão
Santa Teresa - ES - Brasil
MBML

MYRTACEAE
MBML 13775

Det.:

Loc.: Brasil, ES, Mun. Santa Teresa. Alto São Lourenço, Sitio da Cachoeira (Lidio).

Col.: V. Demuner 1482, & E. Bausen & W. Pizziolo

Data: 25/10/2000

OBS.: Arvore 16m, DAP 30cm, fuste 7m, botões florais e flores sépalas bege, pétalas brancas, frutos imaturos de cor verde. Interior de mata, terreno ingrime.

Fig. 5. *Myrcia crassa* - image of holotype.

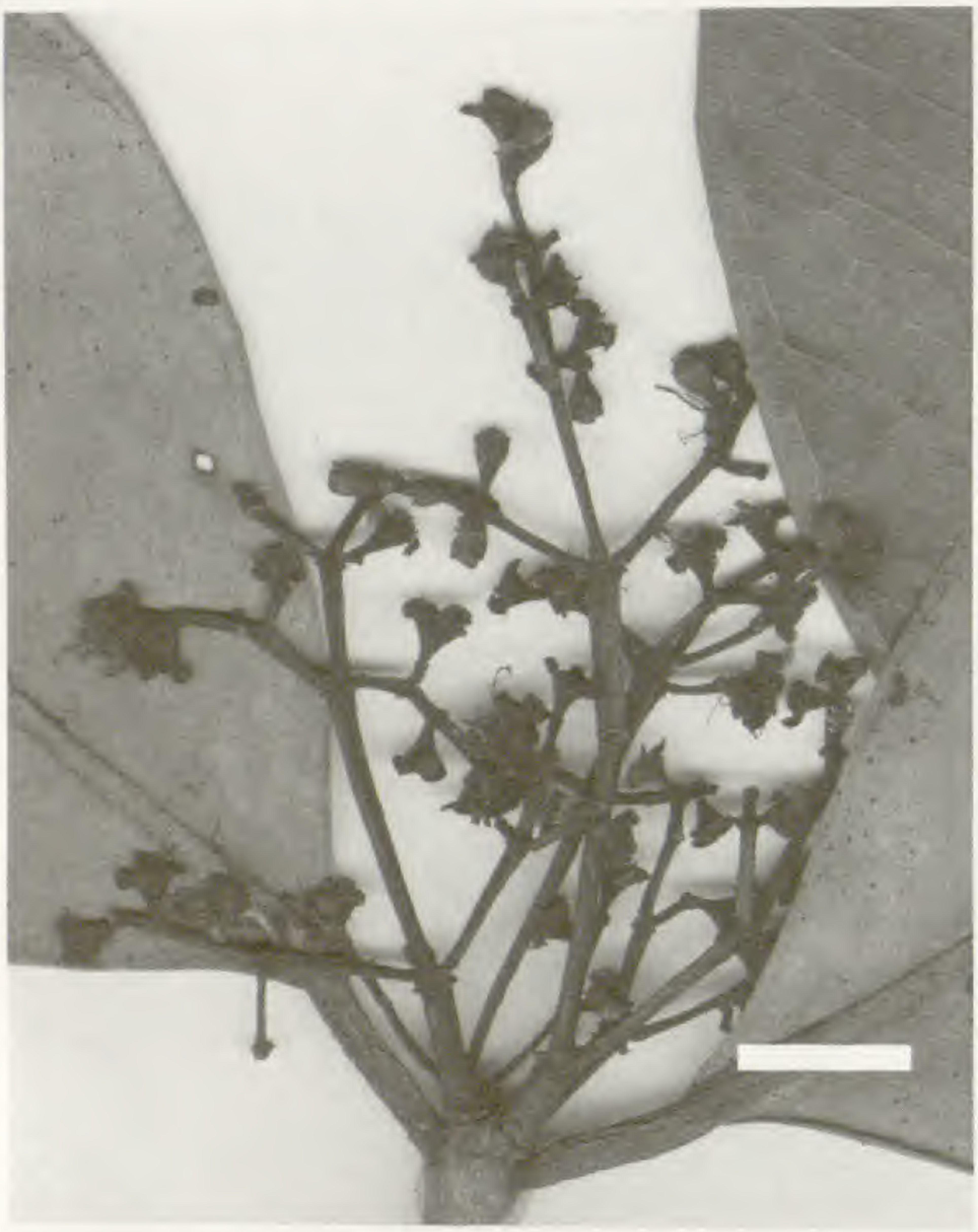

Fig. 6. ***Myrcia crassa*** **- detail of inflorescence (scale: 10 mm).**

to 3 mm in diameter; calyx tube 1–1.5 mm deep; style to 4 mm, the stigma punctiform; ovary with two locules and two ovules per locule. Fruits unknown.

Habitat, dis tribution and phenology.—Tree from montane rainforests, growing at altitudes about 750 m above sea level; presently known only for the municipality of Santa Teresa; flowers collected in October.

Conservation.—This species can be considered as endangered, according to IUCN criteria (IUCN 2001), fitting criteria B1 ab(iii), that is, its presently known range of occurrence is smaller than 5000 km2 (criterium B1) its habitat is severely fragmented (Aguiar et al. 2005:121) (criterium a) and presents a continuing decline in extension (criterium b(iii)), since municipalities in central Espírito Santo have been intensely deforestated (Mendes & Padovan 2000:16).

Affinities.—*Myrcia crassa* is related to *Marlierea silvatica* (O.Berg) Kiaersk. (for description see Berg 1857–1859:145 and Legrand & Klein 1971:479), from which it is distinguished by the following characters:

1. Twigs pilose, to 3 mm wide at the most distal internode; abaxial side of blades pilose; inflorescences with up to 30 flowers; flower buds to 5 mm____________ **Marlierea silvatica**

1. Twigs glabrous, to 6 mm wide at the most distal internode; abaxial side of blades glabrous; inflorescences with up to 60 flowers; flower buds to 3.5 mm____________ **Myrcia crassa**

Etymology.—The epithet means "thick" in Latin, alluding to the large width of the twigs and the stiffness of the blades.

Paratype. **BRAZIL. Espirito Santo, Mun.:** Santa Teresa, 6 Oct 1998, *Kollmann et al.* 682 (BHCB, MBML).

2.2. Myrcia floridissima Sobral, sp. nov. (**Figs. 7–8**). Type: BRAZIL. Minas Gerais, mun.: Marliéria, UTM 0763960, 7814267 UTM 23 K, 5 Apr 2006, *A. Percina s.n.* (holotype: ESAL, isotypes: BHCB, BRIT).

Species *Myrciae pertusae* et *Myrciae lacunosae* proxima; *Myrciae pertusae* trichomis dibrachiatis, petiolis minoribus, bracteolis minoribus et lobis calycinis inaequalibus non strigosis recedit; *M. lacunosae* habitu arboreus, trichomis dibrachiatis, petiolis bracteolisque minoribus et floribus strigosis recedit.

Tree to 6 m high. Bark brown or orange brown, exfoliating; twigs glabrous, 1–2 mm in diameter, terete, exfoliating longitudinally, with the same color as the bark, the internodes 25–50 mm. Leaves with petioles canaliculate, 5–7 × 1.2–1.5 mm; blades lanceolate or elliptic, 110–150 × 20–45 mm, 3–5 times as long as wide, sometimes markedly bullate, discoloured when dry, with white, dibrachiate, asymmetrical trichomes 0.3–0.4 mm, scattered and curled, occasionally absent adaxially and more dense and appressed abaxially, glands more visible abaxially, with less than 0.05 mm in diameter and about 10 per square milimeter; apex acuminate to 10–15 mm; base cuneate; midvein sulcate adaxially and strongly prominent abaxially; lateral veins 17–20 pairs, sulcate or plane adaxially and prominent abaxially, leaving the midvein at angles 60–70 degrees[smaller ??]; marginal veins two, to 2 mm and 0.2–0.6 mm from the margin, the margin

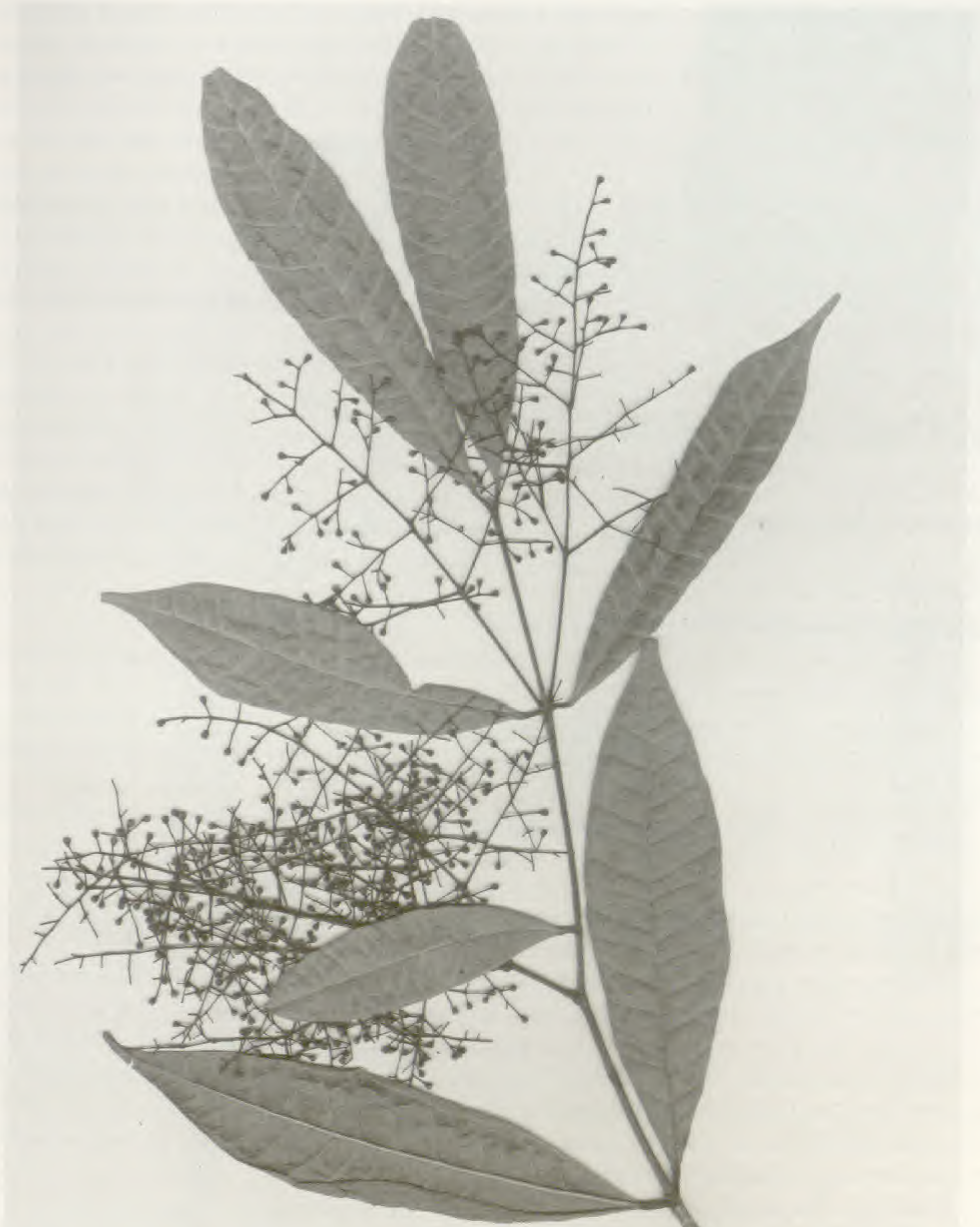
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Fig. 7. *Myrcia floridissima* - image of unmounted holotype.

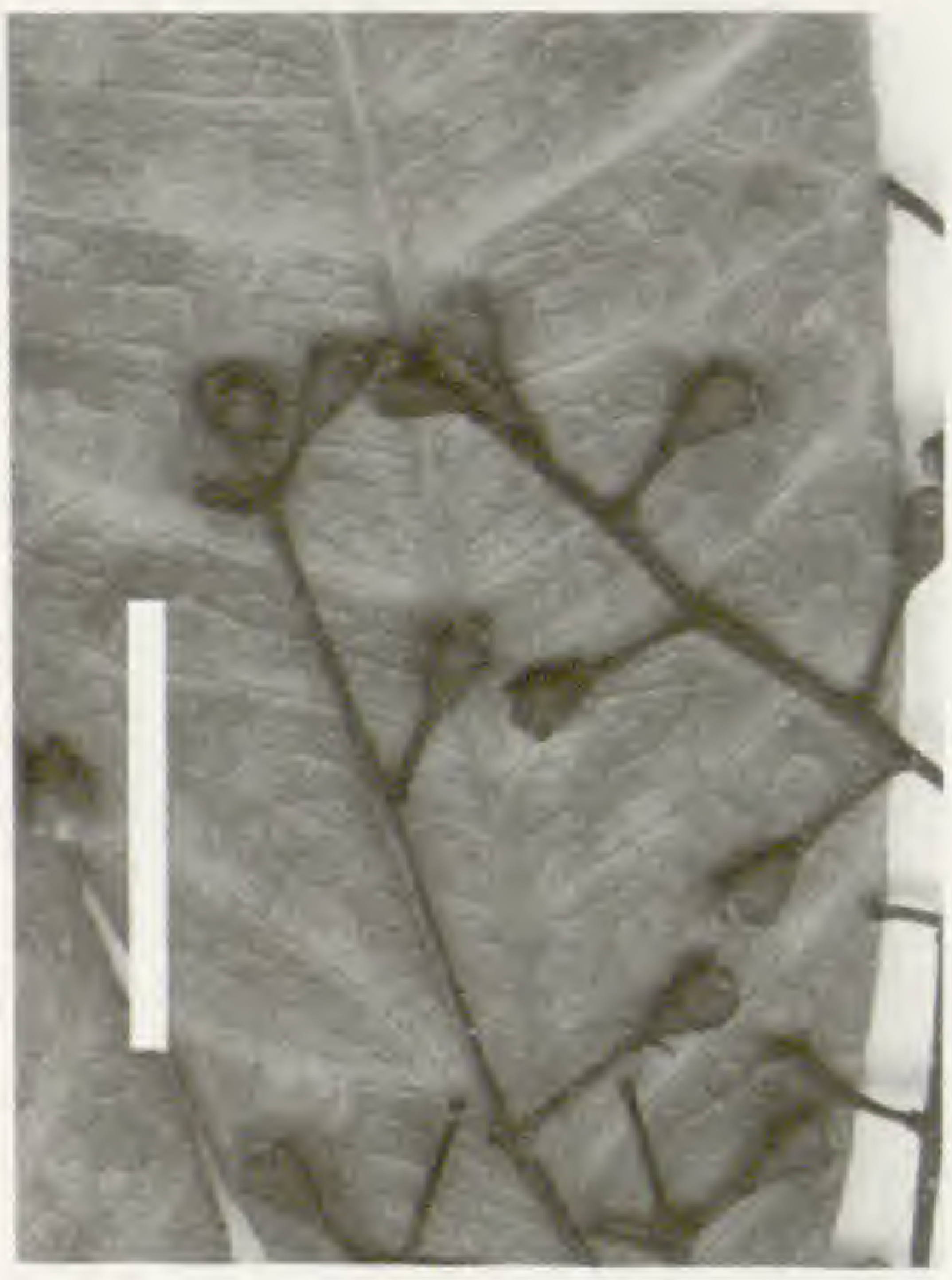


FIG. 8. *Myrcia floridissima* - detail of inflorescences (*França 571*; scale: 10 mm).

itself with a yellow thickening to 0.2 mm. Inflorescences drying dark purple or black, purple [when fresh], axillary or occasionally terminal, paniculiform, pyramidal, ramified two to four times, with dibrachiate trichomes like those of the leaves, the main axis 90–150 × 0.7–1 mm below the first branching, the internodes 10–15 mm, with 1–6 successive branchings, these nearly perfectly opposite one to the other, apparently bearing terminal flowers; pedicels in strict sense possibly absent, the last branches of the inflorescences simulating pedicels, 1–5 × 0.3 mm, occasionally with glabrous, linear [bracts] to 1 × 0.2–0.3 mm; bracteoles the same form and size of hypsophylls; flower buds white, obovate, 2–2.5 × 1.7–2 mm, glabrous; calyx-lobes five, visible in bud, glabrous or with scattered trichomes to 0.1 mm adaxially and cilia to 0.1 mm, unequal, three widely triangular, 0.8–1 × 1 mm, two hemispheric, 1.5–1.8 × 2 mm, strongly reflexed at anthesis; petals white, orbicular, 2 × 2.5 mm, glabrous or with scattered trichomes to 0.1 mm abaxially, reflexed at anthesis; stamens 60–70, white, 6–7 mm, the anthers hemispheric, 0.2–0.3 × 0.3, opening through longitudinal slits, eglandular; staminal ring to 3 mm in diameter, with scattered white trichomes to 0.1 mm; hypanthium 0.5–0.7 mm deep; style 6 mm, the stigma slightly papillose; ovary 2-locular, with two ovules per locule. Fruits unknown.

Habitat, distribution and phenology.—*Myrcia floridissima* is a tree from rainforests (Floresta Atlântica) of eastern Minas Gerais, where it was collected at altitudes about 200 to 500 m above sea level. This species is presently known only for the state park of Rio Doce, in the municipalities of Marliérea and Dionísio, in the eastern portion of the southeastern Brazilian state of Minas Gerais. Flowers were collected in April and September.

Conservation.—Considering the presently available information on this species, it can be considered as an endangered one (EN; IUCN 2001), since it fits criteria B1 ab(iii), that is, its presently known range of occurrence is smaller than 5000 km2 (criterium B1) it grows in a severely fragmented habitat (Aguiar et al. 2005:121) (criterium a) and its habitat presents a continuing decline in extension (criterium b(iii)), due to intense land use in southern Bahia, such as urban expansion and extensive cocoa plantations.

Affinities.—This species resembles *Myrcia pertusa* DC., presently known for the Brazilian state of Amazonas and from Peru (for description see McVaugh 1958:656), and the sympatric *Myrcia lacunosa* (O.Berg) N.Silveira (for description see Berg, 1857–1859:545). *Myrcia pertusa* is set apart by the presence of simple trichomes, smaller petioles (to 2 mm), longer bracteoles (to 5 mm), subequal, rounded and strigose calyx lobes and flowers with 250–300 stamens, while *M. lacunosa* is distinguished by its shrubby or semi-scandent habit, twigs and inflorescences with simple erect trichomes, petioles to 2 mm, bracteoles to 5 mm and densely strigose flowers with triangular calyx lobes.

Etymology.—The specific epithet is derived from the Latin superlative for "flowered," alluding to the profusely branched inflorescences of the type specimen.

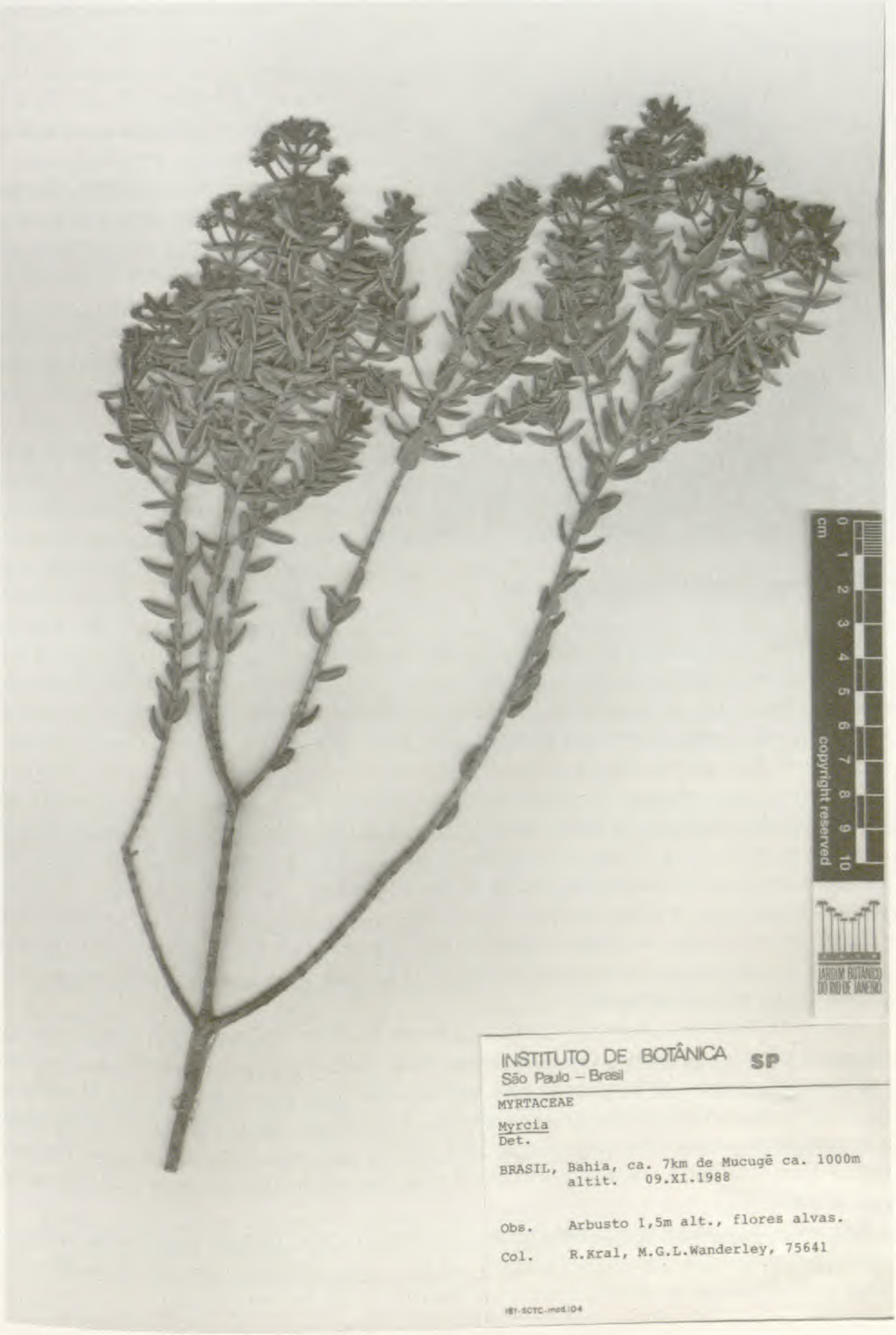
PARATYPE. **BRAZIL. Minas Gerais, Mun. Dionísio:** Parque Estadual do Rio Doce, Mumbaça, 19°48'18"S, 42°32'35"W, 6 Sep 2004, *França et al. 571* (BHCB).

2.3. Myrcia mucugensis Sobral, sp. nov. (Figs. 9–10).

TYPE: BRAZIL. BAHIA, MUN.: Mucugê, 9 Sep 1988, *R. Kral & M.G. Wanderley 75641* (HOLOTYPE: SP; ISOTYPE: BHCB).

Species *Myrciae densae* proxima, sed indumento, foliis sessilibus cordatisque, inflorescentiis congestis et floribus tetrameris recedit.

Shrub 1.5–2 m tall; cortex gray, longitudinally rugose, glabrous, not exfoliating; twigs subterete to complanate and moderately keeled, to 2 mm wide, densely covered with gray or brown arachnoid simple trichomes to 0.2 mm, the internodes 3–5 mm. Leaves sessile, the blades ovate to ovate-triangular, 5–12 × 3–6 mm,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DO RIO DE JANEIRO

INSTITUTO DE BOTÂNICA SP
São Paulo – Brasil

MYRTACEAE

Myrcia
Det.

BRASIL, Bahia, ca. 7km de Mucugê ca. 1000m altit. 09.XI.1988

Obs. Arbusto 1,5m alt., flores alvas.

Col. R.Kral, M.G.L.Wanderley, 75641

IBT-SCTC-mod.104

Fig. 9. *Myrcia mucugensis* - image of isotype.

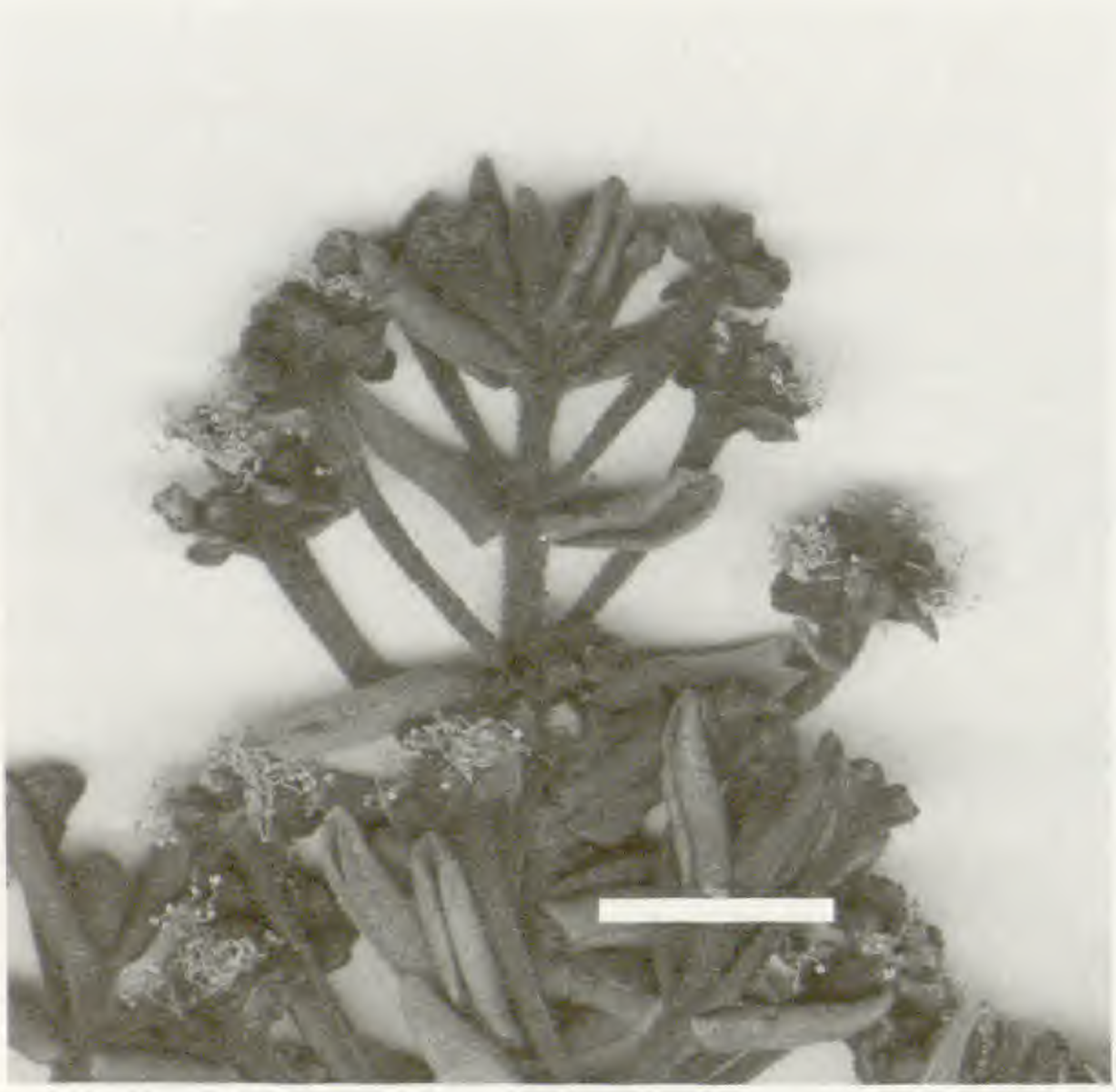


Fig. 10. ***Myrcia mucugensis*** **- detail of inflorescence (scale: 10 mm).**

2–2.5 times as long as wide, discoloured when dry, the adaxial face dull green or somewhat gray, the abaxial face brown or gray, both sides with trichomes as the twigs, those at the abaxial side always more dense than the adaxial one, the trichomes on the adaxial side occasionally deciduous in adult leaves, glands virtually invisible, generally evident against light, smaller than 0.05 mm in diameter and ca. 10 per square milimeter; apex acute to widely acute; base cordiform; midvein slightly sulcate adaxially and prominent abaxially; lateral veins 6–7 pairs, invisible on both sides, leaving the midvein at angles about 60 degrees; marginal vein not evident, the margin itself strongly revolute for at least half the width of the blades, frequently so revolute as to conceal completely the abaxial side. Inflorescences axillary, capituliform, as densely covered with brown trichomes as the twigs, with 8–12 sessile flowers crowded at the apex of a slightly complanate axis 12–15 × 1.5–1.8 mm wide at the apex, the axis occasionally with two ramifications 0.8–1.5 × 0.5 mm with generally three flowers each; bracts at the base of the ramifications or subtending the terminal flowers, elliptic, pilose as the axes, to 2 × 1 mm; bracteoles mostly abortive, sometimes present, linear, to 1.2 × 0.3 mm, with brown trichomes to 0.2 mm; flower buds globose-obovate, densely covered with brown arachnoid trichomes to 0.2 mm, 2 × 1.5–1.8 mm, with four subequal triangular-ovate calyx lobes 1 × 1–1.2 mm, with trichomes on both faces, opening regularly or tearing very slightly the staminal ring, occasionally falling after anthesis; petals 4 or 5, suborbicular, white, to 1 × 1.5 mm, with scattered brown dibrachiate trichomes abaxially; stamens 40 to 50, 3–4 mm, the connective with at least one apical gland ca. 0.05 mm, the anthers orbicular, 0.2 × 0.2–0.3, opening through longitudinal slits; staminal ring glabrous, 1–1.5 mm in diameter; hypanthium to 1.5 mm deep, glabrous; style 5 mm, the stigma minutely capitate and papillose; ovary 2-locular, with two ovules per locule. Fruits globose, to 2 mm in diameter, unripe, either crowned with calyx lobes or with the scar of deciduous ones. Seeds not examined.

Habitat, distribution and phenology.—So far This species has been collected only in "campos rupestres" (rocky open habitats)of the municipality of Mucugê at central Bahia, at altitudes 800–1000 m above sea level.

Conservation.—Although *Myrcia mucugensis* is known from only one municipality, I could not find additional informations relative to the present conditions of its habitat; considering this lack of information, this species can be considered as data deficient (DD), as is the case when "there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status" (IUCN 2001).

Affinities.—This species is apparently related to *Myrcia densa* (DC.) Sobral, a species also collected in campos rupetres of central Bahia (for description see Berg (1857–1859:69), under *Aulomyrcia densa* (DC.) O.Berg). Both species can be distinguished by the characters in the following couplet:

1. Leaves with petioles to 3 mm; blades glabrous or with scattered trichomes, cuneate at base, the margin not revolute; inflorescences paniculiform, two to three times ramified, the secondary branches at least 5 mm long; flowers with five calyx lobes **Myrcia densa**

1. Leaves sessile; blades densely pilose at least abaxially, the base markedly cordate, the margin strongly revolute, sometimes concealing the abaxial side; inflorescences capituliform, occasionally with only one secondary branch to 1.5 mm; flowers with four calyx lobes.________________________ **Myrcia mucugensis**

PARATYPE. **BRAZIL. Bahia. Mun. Mucugê:** 12°59'S, 41°21'W, 25 Jan 1980, *Harley et al. 20619* (ASU, CEPEC, K).

2.4. Myrcia pendula Sobral, sp. nov. (**Figs. 11–12**). TYPE: BRAZIL. BAHIA MUN.: Ibirapitanga, 22 km N of Itamarati on BR-101, then 6.8 km E on road to Embratel tower; Reserva Municipal Cachoeira do Pau, 13°53'27"S, 39°27'33"W, 12 May 2005, *A.M. Amorim, J.L. Paixão, S. Sant'Ana & L.C.J. Gomes 4940* (HOLOTYPE: CEPEC; ISOTYPE: BHCB).

Species *Myrciae croceae* affinis, a qua indumento hispido, foliis subsessilibus, inflorescentiis capitatis et fructis ecostatis recedit.

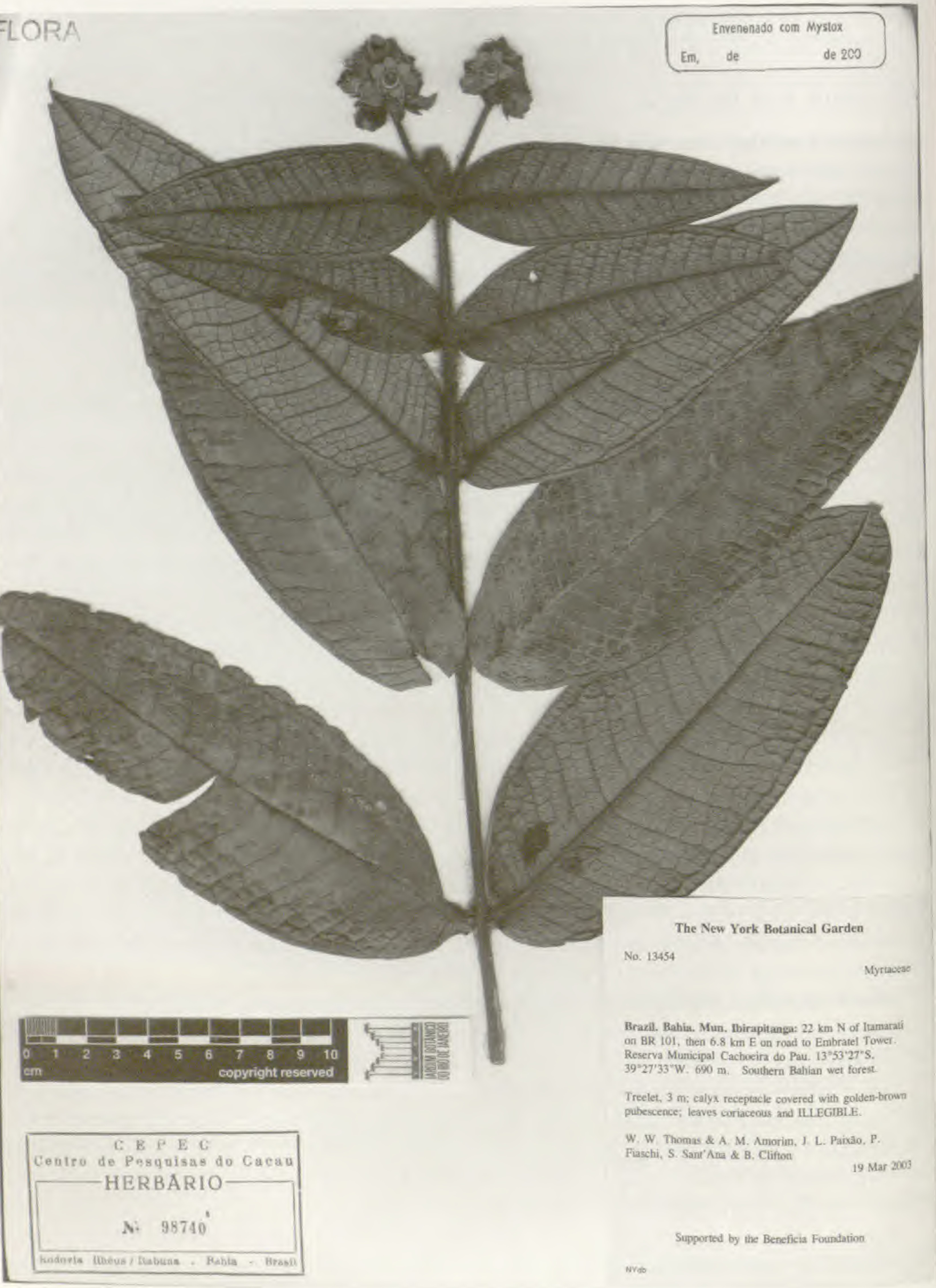
Trees 3–15 m tall. Branches pendulous, terete or slightly flattened, ocasionally weakly channeled longitudinally, 4–5 mm in diameter, with dense simple red-brown erect trichomes to 8 mm long (occasionally deciduous in older twigs), occasionally with straight to slightly curved interpetiolar scars; internodes 40–100 mm long. Leaves sessile or shortly petiolate, the petiole when present to 1 × 4 mm, frequently evident only abaxially; blades ovate-lanceolate, 130–200 × 58–80 mm, 2–2.5 times as long as wide, slightly discoloured when dry, lighter abaxially; glands not evident on the surfaces but visible against light, to 0.1 mm in diameter, about 15 glands per square milimeter; apex acute or acuminate in 3–5 mm; base rounded, frequently with the margins folded in dried specimens; midvein sulcate adaxially, with red, brown or gray simple trichomes to 1 mm, strongly prominent abaxially, there with erect brown trichomes to 5 mm; lateral veins 18–25 pairs, sulcate adaxially and with scattered trichomes as on the midvein, prominent abaxially, [ ] with trichomes as the midvein but these 0.5–1 mm; marginal veins two, 2.5–6 mm and 1–1.3 mm from the margin. Inflorescences with dense brown erect trichomes to 0.5 mm, axillary or terminal, pendulous, mostly capitate, with 3–10 flowers crowded at the apex of an axis, occasionally racemiform or paniculiform and then mostly with one level of ramification, the main fertile axis 40–120 × 1–2.5 mm below the first branching, the secondary axes when present 2 at a same point, to 5 × 1.5 mm; bracts triangular, 10–12 × 5 mm, abaxially with brown appressed trichomes to 1.2–2 mm; pedicels absent; bracteoles triangular as the bracts, 9–10 × 4–6 mm, visibly carenate, abaxially with trichomes as on the bracts, persisting after anthesis; flower buds globose, 8–10 × 9 mm, densely and evenly covered with simple red brown trichomes 1–2 mm; calyx lobes five, triangular to widely triangular, somewhat unequal in size, 4–5 × 5–7 mm, abaxially with trichomes as on the rest of the flower bud and adaxially with gray appressed trichomes to 0.2 mm; petals rounded, to 9–10 × 10 mm; stamens about 200, to 6 mm, the anthers linear-rectangular, to 1 × 0.3 mm, opening longitudinally with a very slight sinuosity, without evident glands; staminal ring 5–6 mm in diameter; hypanthium absent or mostly 0.5 mm deep; style to 10 mm, stigma slightly capitate; ovary 2-locular, with 2 ovules per locule. Fruits globose, smooth, only immature collected, to 20 mm in diameter, densely covered with trichomes as the flowers; seeds one or two per fruit, incompletely developed.

Habitat, distribution and phenology.—*Myrcia pendula* was collected in rainforests in the municipalities of Ibirapitanga and Camamu, at altitudes from 600 to 700 m above sea level; flowers were collected in March and May and fruits in February.

Conservation.—According to IUCN criteria (IUCN 2001), *Myrcia pendula* can be scored as endangered (EN), fitting criteria B1 ab(iii), that is, its presently known range of occurrence is smaller than 5000 km2 (criterium B1), it grows in a severely fragmented habitat (Aguiar et al. 2005:121) (criterium a) and its habitat presents a continuing decline in extension (criterium b(iii)), due to intense land use in southern Bahia, such as urban expansion and extensive cocoa plantations.

Affinities.—This species is apparently related to *Myrcia crocea* (Vell.) Kiaersk. (for description, see Berg (1857–1859:533), under *Gomidesia crocea* (Vell.) O.Berg), another species from atlantic rainforests that grows from Bahia to São Paulo; these species can be distinguished by the characters given in the following couplet:

1. Branches erect; plants with trichomes mostly 1 mm long; leaves with petioles to 8 mm; inflorescences paniculiform, with 30 or more flowers, the secondary axes 10 mm or more; fruits longitudinally sulcate ________________________ **Myrcia crocea**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JARDIM BOTANICO DO RIO DE JANEIRO
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HERBÁRIO
Nº 98740
Rodovia Ilhéus / Itabuna - Bahia - Brasil

The New York Botanical Garden

No. 13454

Myrtaceae

Brazil. Bahia. Mun. Ibirapitanga: 22 km N of Itamaraí on BR 101, then 6.8 km E on road to Embratel Tower. Reserva Municipal Cachoeira do Pau. 13°53'27"S. 39°27'33"W. 690 m. Southern Bahian wet forest.

Treelet, 3 m; calyx receptacle covered with golden-brown pubescence; leaves coriaceous and ILLEGIBLE.

W. W. Thomas & A. M. Amorim, J. L. Paixão, P. Fiaschi, S. Sant'Ana & B. Clifton

19 Mar 2003

Supported by the Beneficia Foundation

NYdb

Fig. 11. *Myrcia pendula* - image of holotype.

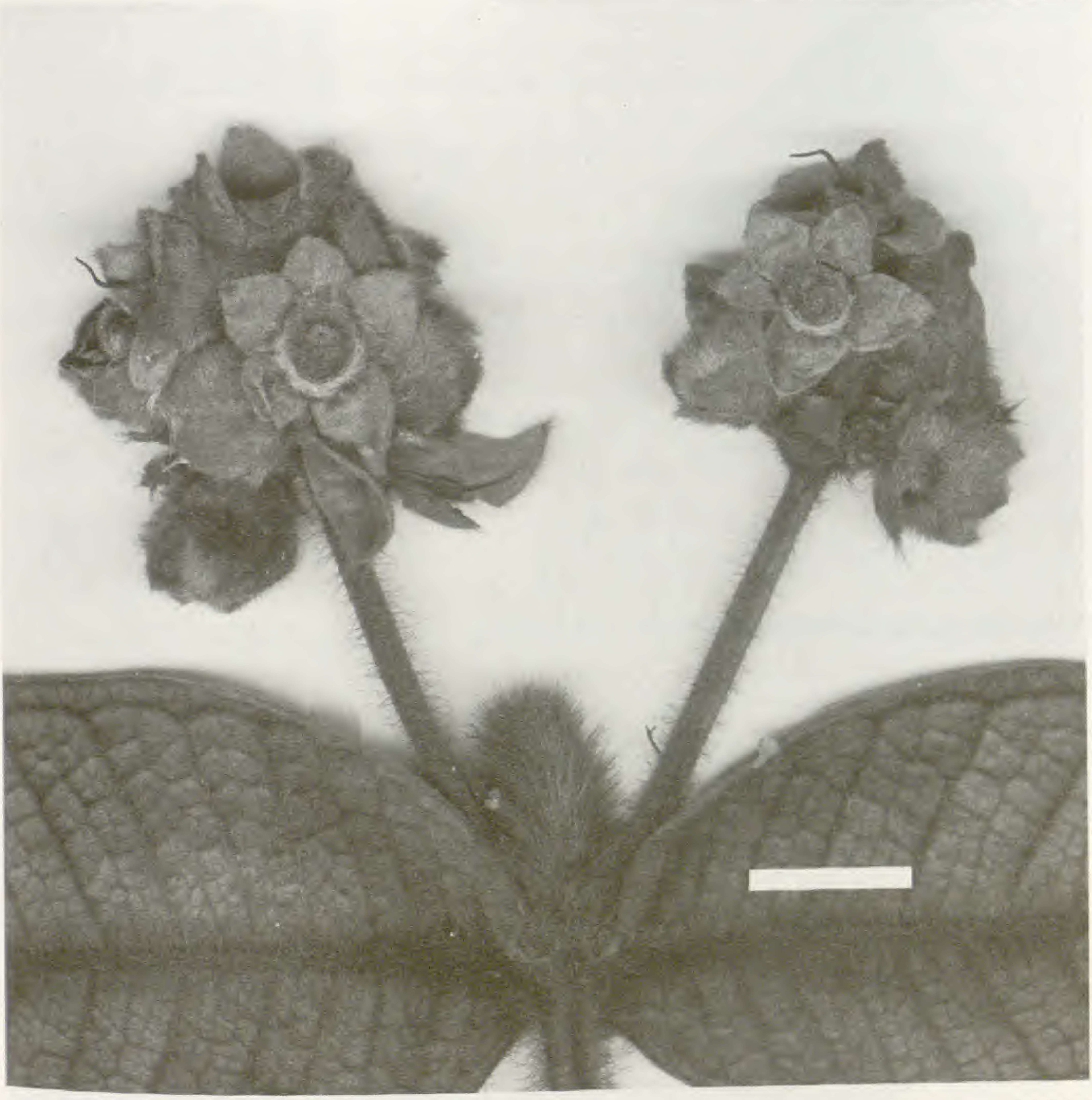


Fig. 12. *Myrcia pendula* - detail of inflorescences (scale: 10 mm).

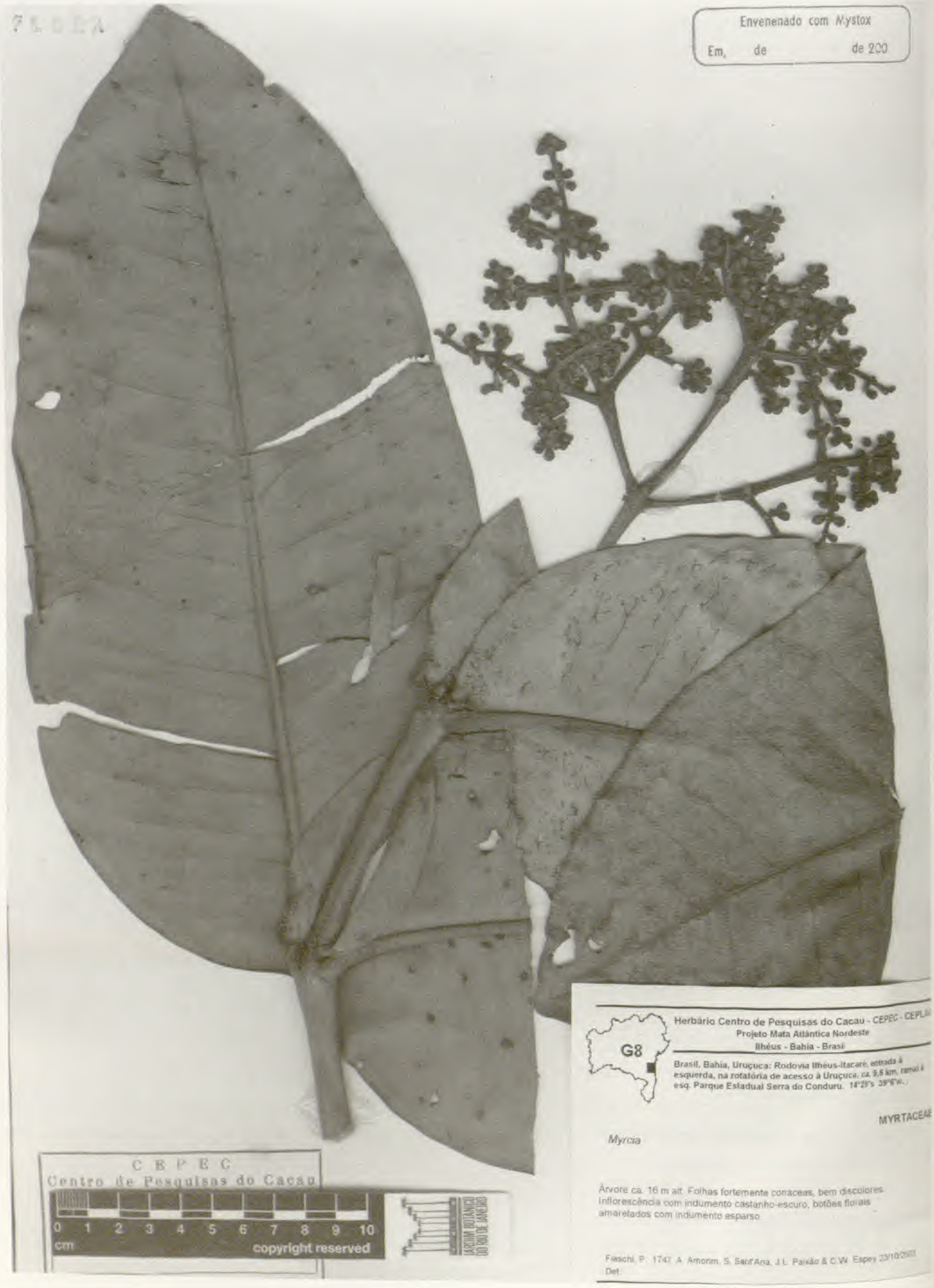
1. Branches pendulous; plants with trichomes to 8 mm long; leaves sessile or with petioles to 1 mm; inflorescences mostly capitate, if racemiform or paniculiform then with up to 10 flowers, the secondary axes to 5 mm; fruits smooth ______ **Myrcia pendula**

Etymology.—The epithet is derived from the Latin word for "pendulous," alluding to the position of the branches of this species in nature.

Paratypes. **BRAZIL. Bahia. Mun. Ibirapitanga:** 22 km N of Itamarati on BR-101, then 6.8 km E on road to Embratel tower, Reserva Municipal Cachoeira do Pau, 13°53'27"S, 39°27'33"W, 19 Mar 2003, *Thomas et al. 13454* (CEPEC). **Mun. Camamu:** Fazenda Exílio, entrada no km 10,7 da BA-650 Camamu-Travessão, ca. 2 km L da sede da Fazenda, 21 Feb 2000, 14°00'07"S, 39°10'07"W, *Jardim et al. 2732* (CEPEC).

2.5. **Myrcia pseudomarlierea** Sobral, sp. nov. (**Figs. 13–14**). Type: BRAZIL. Bahia. mun. Uruçuca:, rodovia Ilhéus-Itacaré, entrada à esquerda na rotatória de acesso a Uruçuca, ca. 9,5 km, ramal à esquerda do Parque Estadual da Serra do Conduru, 14°29'S e 39°6'W, 23 Oct 2003, *P. Fiaschi, A. Amorim, S. Sant'Ana, J.L. Paixão & C.W. Espey 1747* (holotype: CEPEC).

Species *Marliereae affini* proxima, a qua foliis majoribus sessilibus, basi cordati et apicis non acuminatis distincta est.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Projeto Mata Atlântica Nordeste
Ilhéus - Bahia - Brasi
G8
Brasil, Bahia, Uruçuca: Rodovia Ilhéus-Itacaré, entrada à esquerda, na rotatória de acesso à Uruçuca, ca. 9,5 km, ramal à esq. Parque Estadual Serra do Conduru. 14°29'S 39°6'W.
MYRTACEA
Myrcia
Árvore ca. 16 m alt. Folhas fortemente coriáceas, bem discolores. Inflorescência com indumento castanho-escuro, botões florais amarelados com indumento esparso.
Fiaschi, P. 1747 A. Amorim, S. Sant'Ana, J.L. Paixão & C.W. Espey 23/10/200
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Fig. 13. *Myrcia pseudomarlierea* - image of holotype.

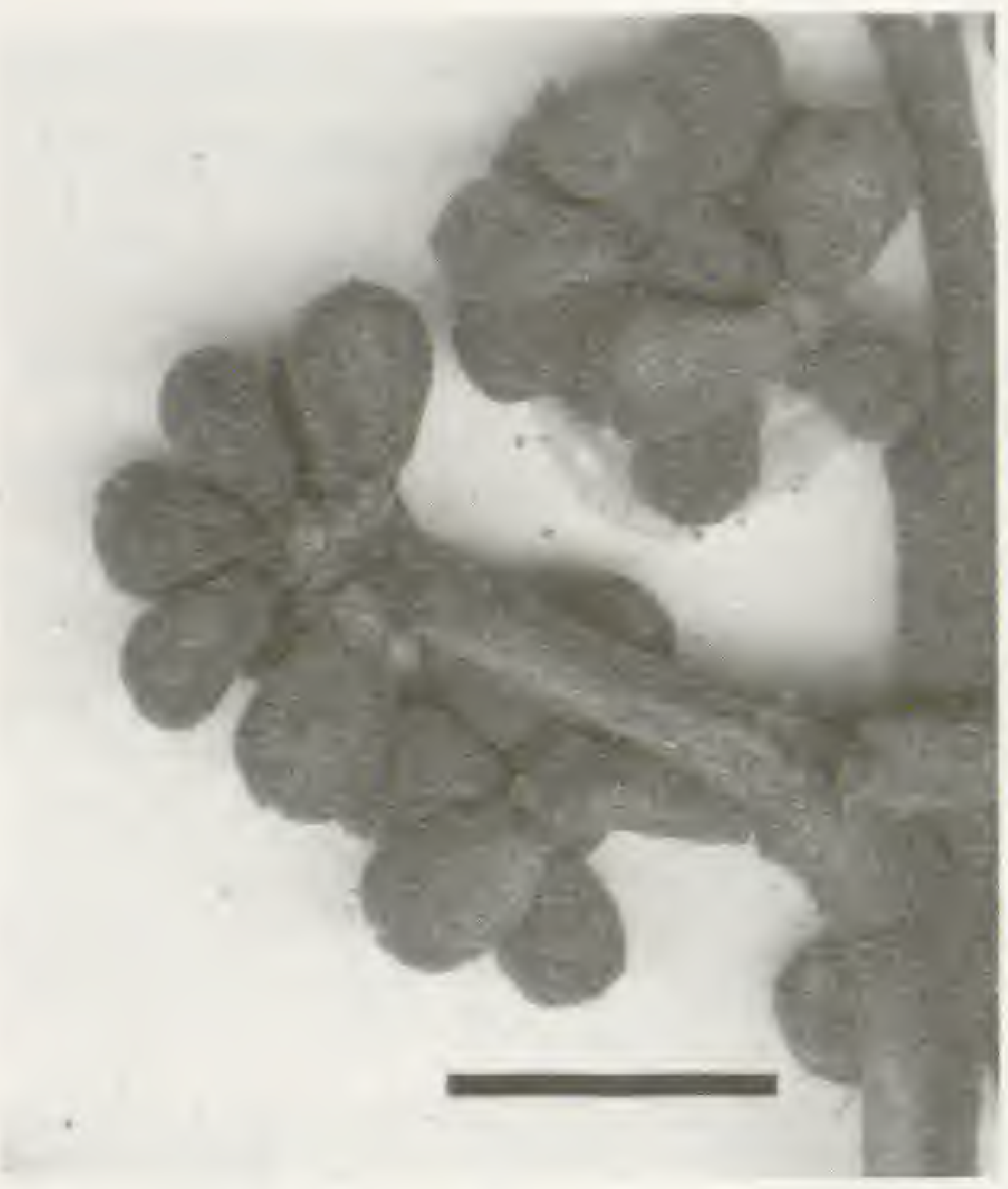


Fig. 14. ***Myrcia pseudomarlierea*** **- detail of inflorescences (scale: 10 mm).**

Trees 4–20 m. Branches and leaves glabrous. Twigs terete or slightly flattened, 4–7 mm in diameter; internodes 30–100 mm long. Leaves sessile; blades lanceolate, obovate-lanceolate or ovate-lanceolate, 130–320 × 55–150 mm, 2–2.5 times as long as wide, discoloured when dry, the abaxial surface lighter; glands not visible against light, moderately excavated in the adaxial side and occasionally barely prominent at the abaxial one, less than 0.1 mm in diameter, 10 to 15 glands per square milimeter; apex acute or rounded; base cordate or rounded, frequently folded or breaking in dried material; midvein sulcate or sometimes flat adaxially, strongly prominent and darker than the rest of the surface abaxially; lateral veins 22–25 pairs, evident and moderately prominent on both sides, with about the same number of thinner secondary lateral veins; marginal veins two, 2.5–5 mm and 1–1.5 mm from the margin. Inflorescences with dense and frequently deciduous glistening brown trichomes to 0.2 mm, terminal, paniculiform, with three to four levels of ramification, the main fertile axis flattened, to 150 × 3–4 mm below the first branching, the secondary axes 2 at a same point, 50–110 × 3 mm; bracts, pedicels and bracteoles absent; flower buds obovate, to 4 × 3 mm, with brown persistent trichomes to 0.2 mm; calyx lobes four, fused between them except apically and tearing at anthesis more or less irregularly, strongly unequal, one of them larger and rounded, sometimes calyptriform, rounded, 2.3–3 mm in diameter, the other three irregularly rounded or triangular, 1–1.5 × 1.5–1.7 mm, with evident glands; petals absent; stamens 90–100, to 4 mm, the anthers subquadrate, 0.3 × 0.2–0.3 mm, opening through longitudinal slits, the connective bearing one evident gland; staminal ring 2–3 mm in diameter; hypanthium 1.5–2 mm deep; style 6–7 mm, stigma punctiform, softly papillose; ovary 2-locular, with 2 ovules per locule. Fruits globose, red when ripe, 12–15 mm in diameter; seeds one per fruit (in three examined fruits) subreniform, 12–15 × 12 mm, the testa light brown, shining, easily detachable, embryo with two folded cotyledons surrounded by an evident hypocotyl.

Habitat, distribution and phenology.—This species grow in coastal rainforests of the municipalities of Camamu, Itacaré and Uruçuca in southern Bahia, at altitudes 100–500 m above sea level. Flowers were collected in October and December; fruits in March and May.

Conservation.—Through IUCN criteria (IUCN 2001), this species could be considered as endangered (EN), fitting criteria B1 ab(iii), since its presently known area of occurrence is smaller than 5000 km2 and its habitat is severely fragmented and suffering a continuing decline (for explanations on criteria and references, see comments under *Myrcia pendula*).

Affinities.—This species resembles *Marlierea affinis* (O.Berg) D.Legrand (for description see Berg (1857–1859:149), under *Eugeniopsis affinis* O.Berg), from which it can be distinguished by the characters in the folowing couplet:

1. Leaves with petioles to 16 mm long and blades to 200 × 60 mm, with acuminate apex and cuneate base; flowers with calyx lobes rounded. __________ **Marlierea affinis**
1. Leaves sessile, to 320 × 150 mm, with acute apex and cordate base; flowers with unequal calyx lobes, one of them somewhat calyptriform. __________ **Myrcia pseudomarlierea**

Etymology.—The epithet is derived from the Greek work meaning "false" and *Marlierea*, alluding to the close resemblance of this plant to a species presently assigned to *Marlierea*.

Paratypes. **BRAZIL. Bahia. Mun. Camamu:** rodovia BA-650, Camamu-Travessão, fazenda Zumbi dos Palmares, Cachoeira de Crespe, 12 Nov 2004, *Paixão et al.* 282 (CEPEC). **Mun. Itacaré:** APA de Itacaré/Serra Grande, km 12 da rodovia Itacaré-Serra Grande, 19 May 2000, *Sant'Ana et al.* 875 (CEPEC); estrada que liga a torre da Embratel com a estrada BR-101/Itacaré, a 5,8 km da entrada; 200–300 m, 21 Oct 1979, *Mori & Benton 12857* (CEPEC); mata parcialmente perturbada na estrada Itacaré-Taboquinhas, ao lado do loteamento da Marambaia, 20 Nov 1991, *Amorim et al. 399* (CEPEC). **Mun. Uruçuca:** rodovia Ilhéus-Itacaré, 7.3 km N of Serra Grande on road to Itacaré, 14°25'S, 39°01'W, 7 May 1992, *Thomas et al. 9201* (CEPEC).

2.6. Myrcia pseudospectabilis Sobral, sp. nov. (**Figs. 15–16**). Type: BRAZIL. Bahia. Mun. Ilhéus: rodovia Ilhéus-Itacaré (BA-001), na altura do km 20, entrada à esquerda; acesso ao Retiro, ramal vicinal 5,5 km à direita para a Lagoa Encantada, 14°35'10"S, 39°07'2"W, 27 Nov 2004, *P. Fiaschi, J.L. Paixão, S.C. Sant'Ana & L.C.J. Gomes 2656* (holotype: CEPEC; isotype: BHCB).

Species *Myrciae spectabili* proxima, a qua habitu fruticoso, ramis ecallosis, foliis angustioribus, basi cordatis et fructis glabratis recedit.

Shrubs to small trees 1–6 m. Branches and adult leaves glabrous or with very scarce white trichomes to 0.3 mm. Twigs terete or slightly flattened, 3–4 mm in diameter, scarcely or not longitudinally striate, occasionally with straight to slightly curved interpetiolar scars; internodes 40–80 mm long. Leaves petiolate, the petiole 2.5–4 × 2–2.5 mm, frequently evident only abaxially; blades lanceolate, oblong-lanceolate or ovate-lanceolate, 130–220 × 30–55 mm, 4–4.5 times as long as wide, discoloured when dry, lighter abaxially; glands visible against light, moderately prominent abaxially, to 0.1 mm in diameter, 6 to 10 glands per square milimeter; apex acuminate (acumen 15–20 mm) or acute; base cordate, rounded or slightly auriculate above the petiole; midvein biconvex adaxially, prominent abaxially; lateral veins 16–27 pairs, evident and moderately prominent at least abaxially, with about the same number of much thinner secondary lateral veins; marginal veins two, 2–3 mm and 0.5–0.6 mm from the margin. Inflorescences with scarce white or ochraceous appressed simple trichomes to 0.3 mm, terminal, paniculiform, with two to three levels of ramification, the main fertile axis 80–130 × 2.5–3 mm below the first branching, the secondary axes 2 at a same point, 20–40 × 1–2 mm; bracts mostly absent, when present linear-lanceolate, those at the base of the first branching to 10 × 2 mm, those of the higher branchings to 5 × 0.5 mm; pedicels absent; bracteoles lanceolate, to 2 × 0.3–0.5 mm, deciduous at anthesis; flower buds obovoid or pyriform, to 5 × 3 mm, with simple, ochraceous or gray persistent trichomes to 0.2 mm densely covering the ovary, the calyx lobes with somewhat clearer and less dense trichomes to 0.3 mm, the ovary markedly wrinkled in dried specimens; calyx lobes five, triangular, slightly unequal, 1–1.5 × 2 mm; petals rounded or elliptic, 3–6 × 2–5 mm; stamens 40–50, to 6 mm, the anthers linear-rectangular, 1–1.3 × 0.4 mm, opening longitudinally, eglandular; staminal ring about 2 mm in diameter; hypanthium to 1 mm deep; style to 8 mm; stigma punctiform; ovary 2-locular, with 2 ovules per locule. Fruits glabrous, globose, purple or black when ripe, 10–12 mm in diameter; seeds one or two per fruit, to 10 mm, the testa easily detachable, embryo with two folded cotyledons surrounded by an evident hypocotyl, this with simple white trichomes to 0.3 mm near the proximal part.

Habitat, distribution and phenology.—*Myrcia pseudospectabilis* grows in coastal rainforests of southern Bahia, at altitudes from 170 to 510 m above sea level; flowers were collected in November and fruits from February to July.

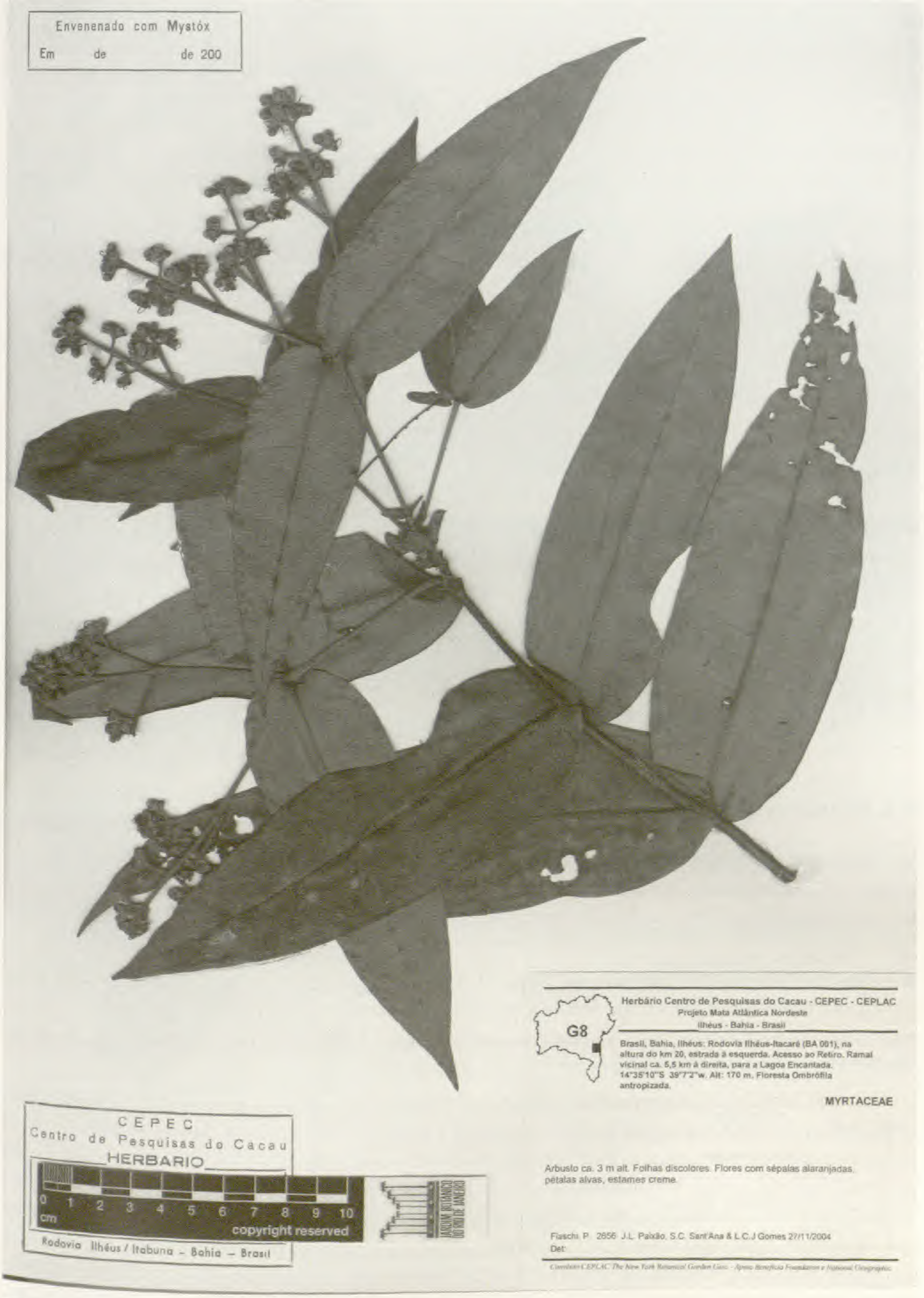
Conservation.—This species can be considered, according to IUCN criteria (IUCN 2001) as endangered (EN), fitting criteria B1 ab(iii), since its presently known area of occurrence is smaller than 5000 km2 and its habitat is severely fragmented and declining (for explanations on criteria and references, see comments under *Myrcia pendula*).

Affinities.—This species is apparently related to *Myrcia spectabilis* DC., a species widespread in coastal Brazil from Bahia to Santa Catarina (for description see Berg (1857–1859:12), under *Gomidesia spectabilis* (DC.) O.Berg); both species can be set apart by the following characters:

1. Tree to 15 m tall or more; twigs with an interpetiolar callose scar; leaves with blades to 200 × 70 mm, the base acute to obtuse; fruits with yellow appressed trichomes. ____ **Myrcia spectabilis**
1. Tree to 6 m tall; twigs devoid of interpetiolar scar; leaves with blades to 220 × 55 mm, the base cordate; fruits glabrous. ____ **Myrcia pseudospectabilis**

Etymology.—The epithet is derived from the Greek word for "false" and "spectabilis," alluding to the resemblance between this species and *Myrcia spectabilis*.

Paratypes. **BRAZIL. Bahia. Mun. Ilhéus:** rodovia Ilhéus-Itacaré (BA-001), na altura do km 20, entrada à esquerda, acesso ao Retiro, ramal vicinal 5,5 km à direita para a Lagoa Encantada, 14°35'10"S, 39°07'2"W, 19 Feb 2005, *Fiaschi et al. 2726* (CEPEC). **Mun. Santa Luzia:** estrada a 11,3 km E da sede do município, Serra da Onça, ca. 4,5 km da entrada, 23 Jul 1996, *Jardim et al. 854* (CEPEC); estrada de Serra Grande para Uruçuca, área do inventário do plano de manejo, mata da torre do celular, 14°29'59"S, 39°06'54"W, 18 Mar 2004, *Fiaschi et al. 2069* (CEPEC); idem, 2 Apr 2004, *Fiaschi et al. 2216* (CEPEC); Serra da Onça, 10.8 km NE of Santa Luzia, on Una-Santa Luzia Road, then 4.2 km N on road to Serra da Onça, 15°30'S, 39°30'W, 21 Nov 1996, *Thomas et al. 11363* (BHCB, CEPEC). **Mun. Uruçuça:**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Herbário Centro de Pesquisas do Cacau - CEPEC - CEPLAC
Projeto Mata Atlântica Nordeste
Ilhéus - Bahia - Brasil
G8
Brasil, Bahia, Ilhéus: Rodovia Ilhéus-Itacaré (BA 001), na altura do km 20, estrada à esquerda. Acesso ao Retiro. Ramal vicinal ca. 5,5 km à direita, para a Lagoa Encantada. 14°35'10"S 39°7'2"w. Alt: 170 m. Floresta Ombrófila antropizada.
MYRTACEAE
Arbusto ca. 3 m alt. Folhas discolores. Flores com sépalas alaranjadas, pétalas alvas, estames creme.
Fiaschi, P. 2856 J.L. Paixão, S.C. Sant'Ana & L.C.J Gomes 27/11/2004
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Rodovia Ilhéus / Itabuna – Bahia – Brasil

Fig. 15. *Myrcia pseudospectabilis* - image of holotype.

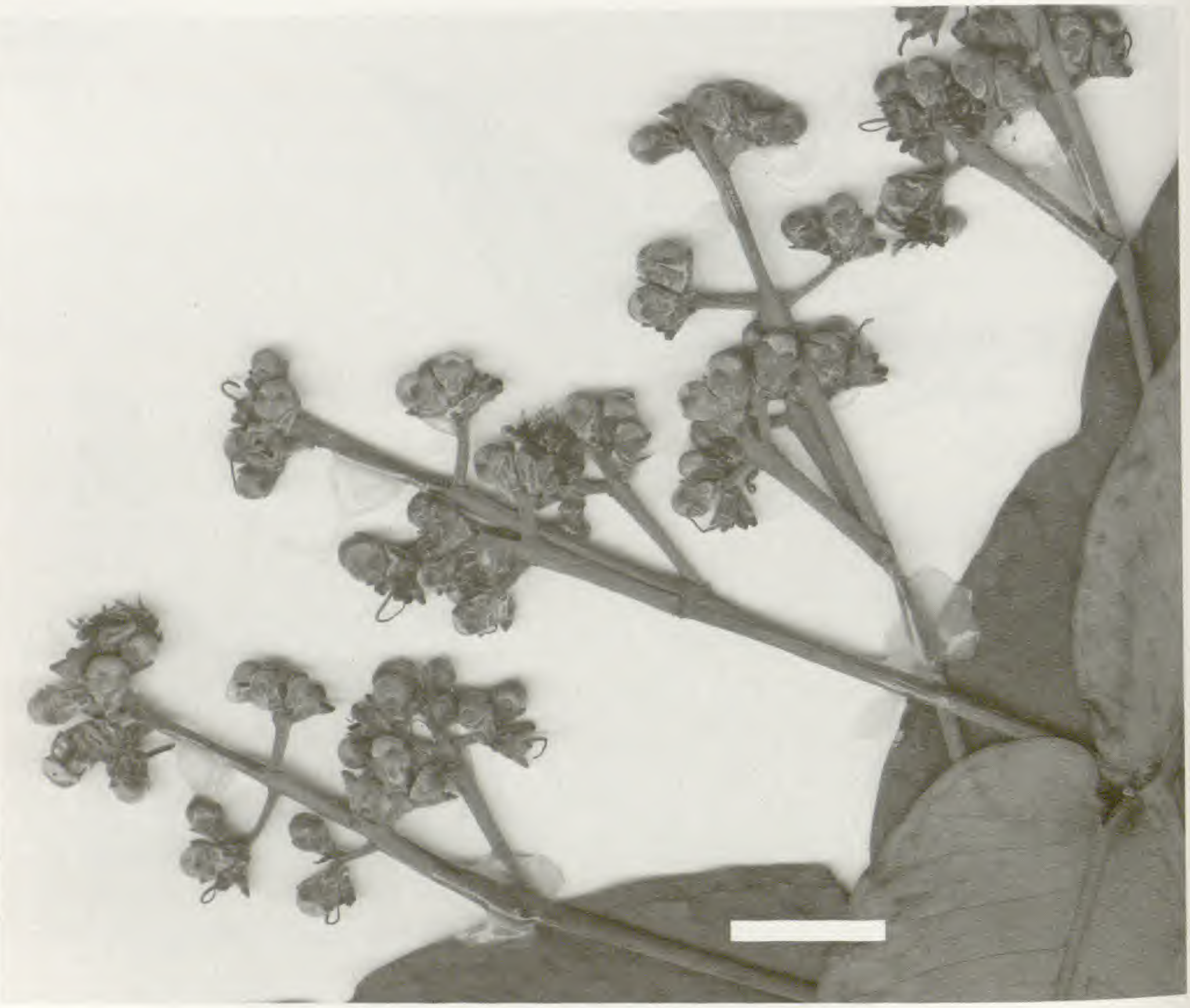


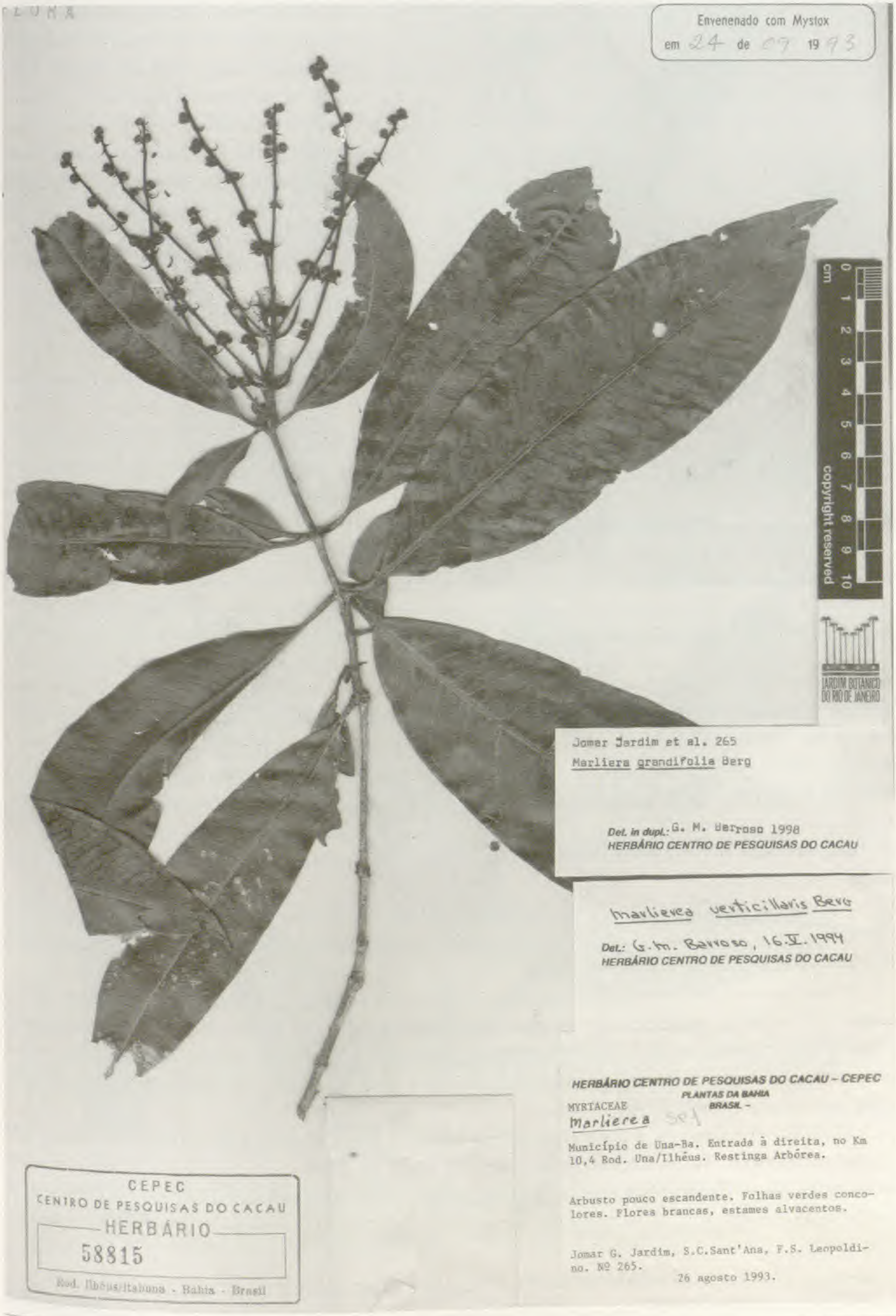
Fig. 16. *Myrcia pseudospectabilis* - detail of inflorescences (scale: 10 mm).

distrito de Serra Grande, estrada Serra Grande-Itacaré, 7,3 km a partir de Serra Grande, Fazenda Lagoa, do conjunto Fazenda Santa Cruz, 13 May 1999, *Amorim et al. 3073* (CEPEC); 7 Sep 1991, *Carvalho et al. 3643* (CEPEC); 7 Sep 1991, *Carvalho et al. 3662* (CEPEC); 3 km N of Serra Grande on road to Itacaré, Fazenda Lagoa, 14°25'S, 39°01'W, 6 May 1993, *Thomas et al. 9807* (CEPEC); 9 Feb 1994, *Thomas et al. 10345* (CEPEC); 14°25'24"S, 39°03'38"W, 24 Apr 1995, *Thomas et al. 10928* (CEPEC); 15 Nov 1995, *Thomas et al. 11006* (CEPEC).

2.7. Myrcia tetraphylla Sobral, sp. nov. (**Figs 17–18**). Type: BRAZIL. Bahia. mun. Una: entrada à direita no km 10,4 da rodovia Una-Ilhéus, 26 Aug 1993, *J.G. Jardim, S.C. Sant'Ana & F.S. Leopoldino 265* (holotype: CEPEC).

Species *Myrciae eumecephyllae* et *M. clavijae* proxima; a prima foliis verticillatis recedit et altera petiolis longioribus, laminis cuneatis, lobis calycinis exaristatis et fructis majoribus recedit.

Shrubs to trees 2–8 m. Flowering branches pendulous. Branches and inflorescences with dense simple brown trichomes to 0.5 mm. Internodes usually unequal in a branch, 6–60 mm long. Leaves petiolate, verticillate, 3–4 at a same point of the branch; petioles 10–20 × 1–3 mm, thickened and somewhat darker at the proximal half, with simple brown trichomes 0.5–1 mm; blades narrowly lanceolate, oblanceolate or oblong, 150–270 × 15–60 mm, 4.5–10 times as long as wide, discoloured when dry, the adaxial side dull dark green and the abaxial light brown, with very scattered simple, white, and easily breakable trichomes to 1 mm on both surfaces near the midvein; glands not visible against light, occasionally barely visible on the blade surface, about 0.1 mm in diameter and less than 10 glands per square milimeter; apex acute or acuminate, the acumen 15–45 mm; base cuneate or attenuate; midvein strongly prominent on both sides, sometimes clearer than the rest of the blade; lateral veins 25–35 pairs, evident and moderately prominent on both sides.



Envenenado com Mystox
em 24 de 07 1993

Jomar Jardim et al. 265
Marliera grandifolia Berg

Det. in dupl.: G. M. Barroso 1998
HERBÁRIO CENTRO DE PESQUISAS DO CACAU

marlierea verticillaris Berg

Det.: G. m. Barroso, 16.V.1994
HERBÁRIO CENTRO DE PESQUISAS DO CACAU

HERBÁRIO CENTRO DE PESQUISAS DO CACAU – CEPEC
PLANTAS DA BAHIA
BRASIL –
MYRTACEAE
Marlierea sp1

Município de Una-Ba. Entrada à direita, no Km 10,4 Rod. Una/Ilhéus. Restinga Arbórea.

Arbusto pouco escandente. Folhas verdes concolores. Flores brancas, estames alvacentos.

Jomar G. Jardim, S.C.Sant'Ana, F.S. Leopoldino. Nº 265.
26 agosto 1993.

CEPEC
CENTRO DE PESQUISAS DO CACAU
HERBÁRIO
58815
Rod. Ilhéus/Itabuna - Bahia - Brasil

Fig. 17. *Myrcia tetraphylla* - image of holotype.

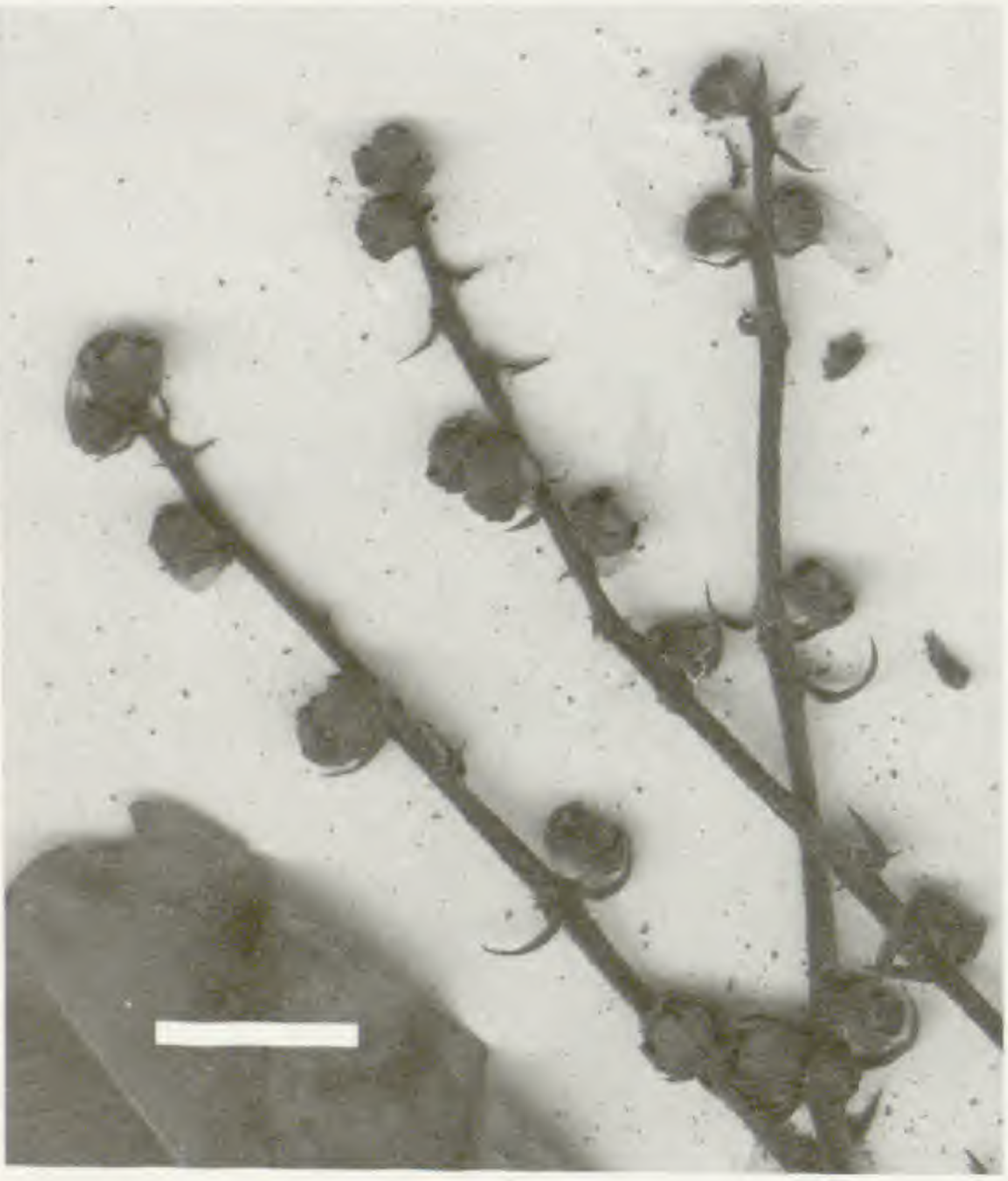


Fig. 18. *Myrcia tetraphylla* - detail of inflorescences (scale: 10 mm).

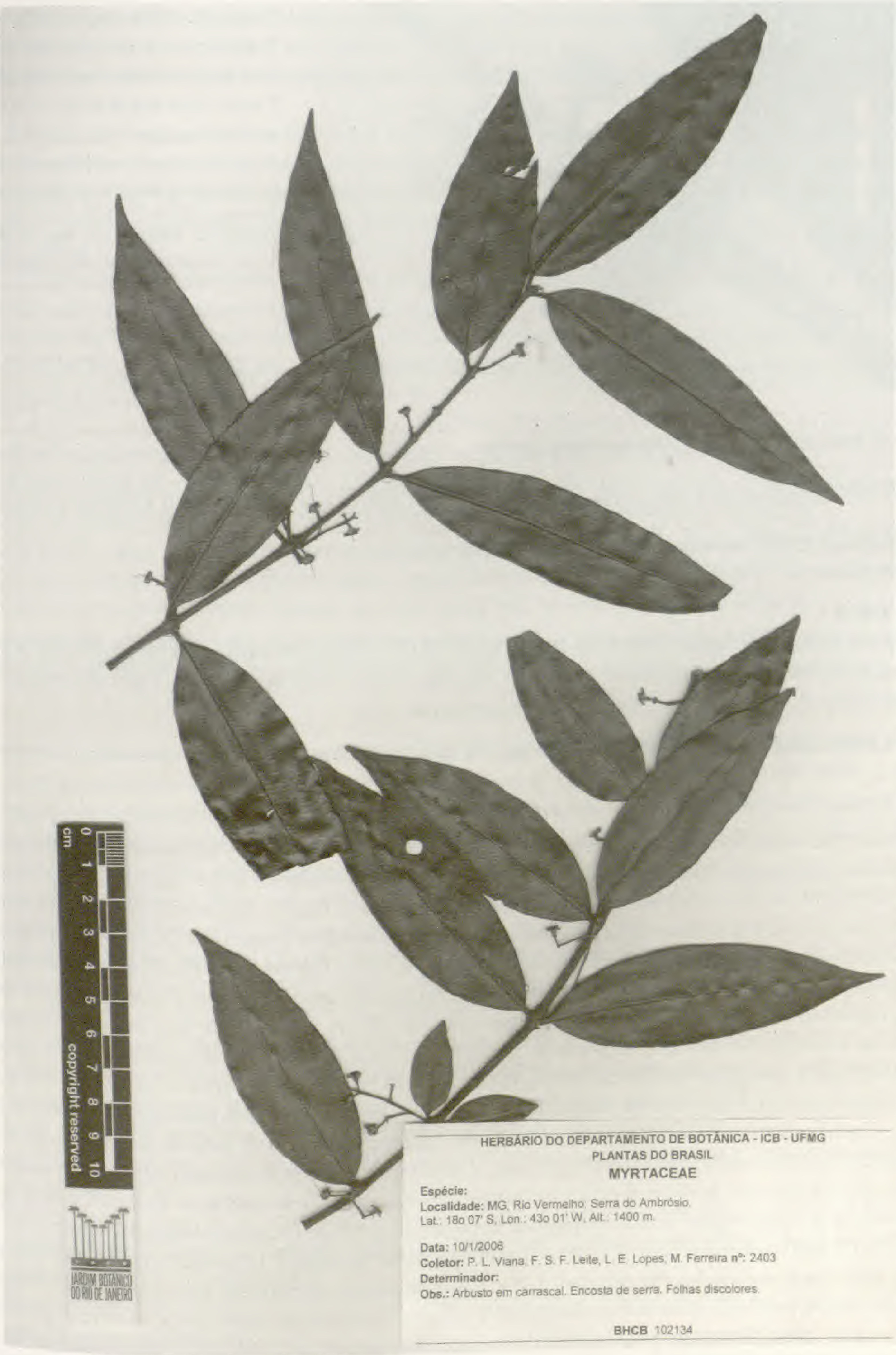
with about twice as many secondary lateral veins; marginal vein 1–5 mm, occasionally a second, 0.8–1 mm, from the margin. Inflorescences terminal, paniculiform, the main fertile axis 20–80 × 2–3 mm below the first branching, the secondary axes verticillate, 4–6 at a same point, longer than the primary axis, 100–200 × 1–1.5 mm; bracts at the base of the inflorescence whorled in 3–4 series, with brown trichomes to 0.5 mm, the proximal ones triangular, 2–4 × 1.5 mm, the distal ones narrowly triangular, 15 × 1.8 mm; bracts at the base of secondary branches in one series, narrowly triangular, 18 × 2 mm; bracts at the base of flowers along the secondary branches linear, 5–10 × 0.2–0.3 mm, persisting after anthesis, pilose as the bracts of the main axis and frequently evidently curved; pedicels absent; bracteoles one or two by flower, if two very unequal, 1 × 0.2–0.3 and 2 × 0.3 mm (in some cases three bracteoles could be observed, suggesting that what is here considered bracteoles could possibly be remnant bracts of an aborted tertiary axis); flower buds obovate, 3–4 × 3–4 mm, with brown trichomes to 0.2 mm on the ovary; calyx lobes unequal in size and shape, two of them rounded or widely triangular, 1.2–1.5 × 1.8 mm, three triangular, 0.8 × 1 mm, ciliate and with evident glands; petals rounded or obovate, glabrous, 2.5–3 × 3 mm; stamens 40–50, 3–4 mm, the anthers subquadrate, 0.3 × 0.2 mm, opening through longitudinal slits; staminal ring with scarce white trichomes to 0.2 mm, 2–2.2 mm in diameter; hypanthium 0.5–1 mm deep; style 6 mm, stigma punctiform; ovary 2-locular, with 2 ovules per locule. Fruits globose, purple when ripe, 15–22 mm in diameter; seeds 1–2, reniform, 10 × 8 mm, the testa brown, shining and easily detachable; embryo immature, not observed.

Habitat, distribution and phenology.—*Myrcia tetraphylla* grows in rainforests from four municipalities in southern coastal Bahia, at altitudes from the sea level to about 100 m; flowers were collected in January and fruits in January, October and November.

Conservation.—Considering IUCN criteria (IUCN 2001) for assigning conservation status for species, this species could be considered as endangered (EN), fitting criteria B1 ab(iii), that is, its presently known range of occurrence is smaller than 5000 km2, it grows in a severely fragmented habitat and its habitat presents a continuing decline in extension due to intense land use (for explanations on criteria and references, see comments under *Myrcia pendula*).

Affinities.—This species is apparently closely related to *Myrcia eumecephylla* (O.Berg) Niedenzu, from coastal southeastern Brazil (for description see Berg (1857–1859:98) and *Myrcia clavija* Sobral, from the montane forests of the Brazilian state of Minas Gerais (for description see Sobral & Couto 2006); it can be easily distinguished from *M. eumecephylla* by the verticillate leaves, and from *M. clavija* by the following characters:

1. Petioles to 7 mm; blades with lateral veins to 60 pairs and base obtuse to cordate; calyx lobes aristate to 2 mm; fruit to 12 mm in diameter ____ **Myrcia clavija**
1. Petioles to 20 mm; blades with lateral veins to 35 pairs and base attenuate; calyx lobes rounded or triangular, not aristate; fruit to 22 mm in diameter ____ **Myrcia tetraphylla**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JARDIM BOTÂNICO
DO RIO DE JANEIRO

HERBÁRIO DO DEPARTAMENTO DE BOTÂNICA - ICB - UFMG
PLANTAS DO BRASIL
MYRTACEAE

Espécie:
Localidade: MG, Rio Vermelho: Serra do Ambrósio.
Lat.: 18o 07' S, Lon.: 43o 01' W, Alt.: 1400 m.

Data: 10/1/2006
Coletor: P. L. Viana, F. S. F. Leite, L. E. Lopes, M. Ferreira **nº:** 2403
Determinador:
Obs.: Arbusto em carrascal. Encosta de serra. Folhas discolores.

BHCB 102134

Fig. 19. *Plinia espinhacensis* - image of holotype.

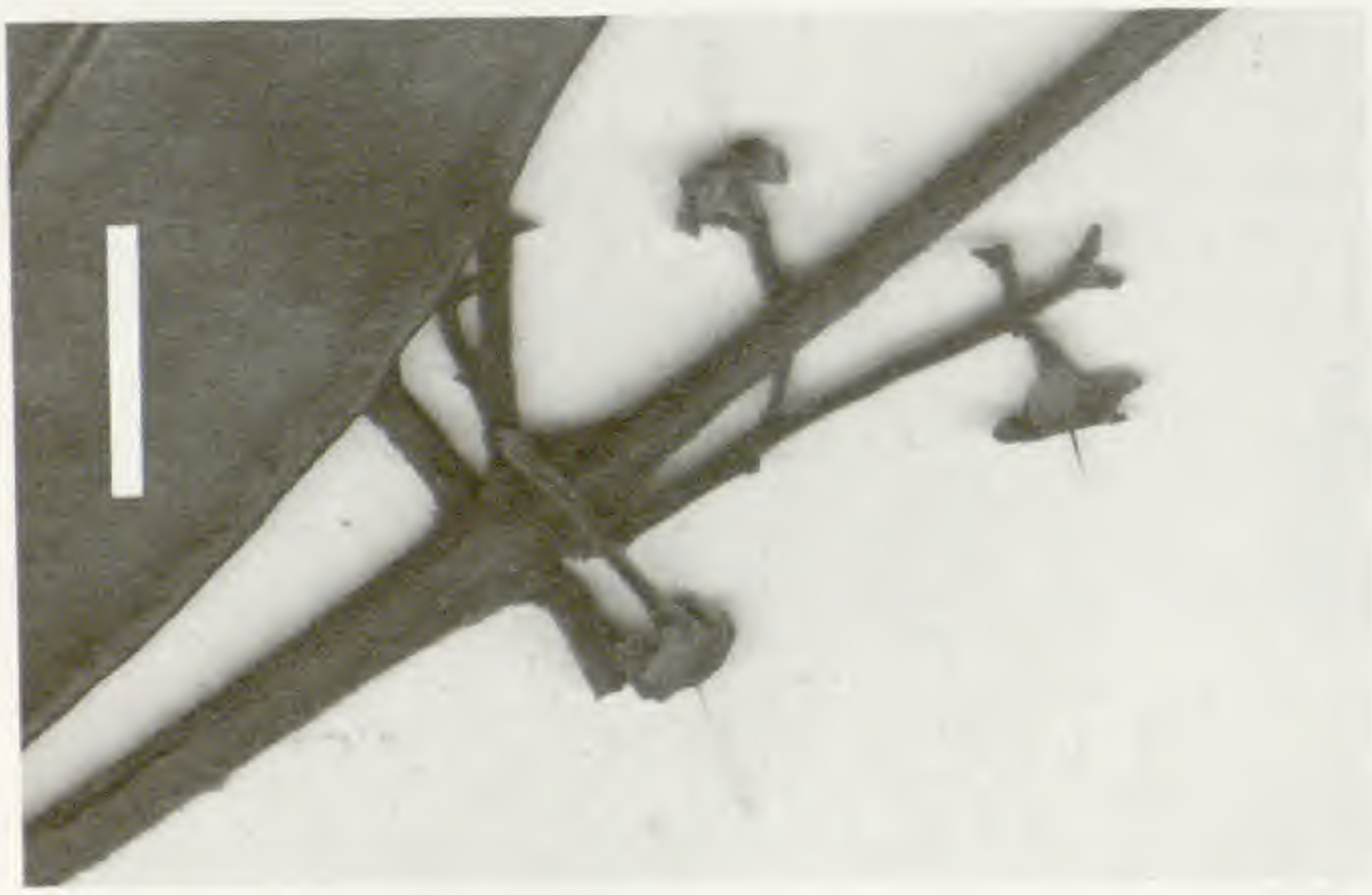

Fig. 20. *Plinia espinhacensis* - detail of inflorescences (scale: 10 mm).

Etymology.—The epithet is derived from the Greek words for "four" and "leaves," alluding to the verticillate leaves of the species.

Paratypes. **BRAZIL.** estrada São José da Vitória - Buerarema, ramal à direita, ca. 1 km de São José, estrada de acesso para a Pedra Branca, 15°05'S, 39°19'W, 15 Oct 2003, *Fiaschi et al. 1689* (CEPEC). **Mun. Gandu:** Br-101, ao norte, 21 Oct 1970, *Santos 1164* (CEPEC). **Mun. Ilhéus:** entrada entre Sururu e Vila Brasilo, a 6–14 km de Sururu, a 12–20 km SE de Buerarema, 27 Oct 1979, *Mori & Benton 12887* (CEPEC). **Mun. Una:** km 17 da estrada que liga a Rod. BR-101(São José) à Rod. BA-215, 29 Oct 1978, *Mori & Thompson 11021* (CEPEC); Reserva Biológica do Mico-leão (Ibama),entrada no km 46 da rodovia BA-001 Ilhéus-Una, 15°09'S e 39°05'W, 09 Nov 2003, *Amorim et al. 1427* (CEPEC); 13 Sep 2003, *Amorim et al. 1334* (CEPEC); 7 Jan 2003, Jardim et al. 6 (CEPEC); 14 Nov 1992, *Thomas et al. 9416* (CEPEC); rod. Una a Xapuri, Dendhawea S/A, fazenda Iguaçu, 28 Oct 1971, *Pinheiro 1681* (CEPEC); Rebio de Una, sede Maruim, 10 Nov 1998, *Amorim et al. 2636* (CEPEC); Reserva Biológica de Una, Picada do Marimbondo, 15°10'S, 39°04'W, 24 Nov 1996, *Thomas et al. 11409* (CEPEC).

3. **Plinia** L.

Plinia is an American genus with about 20 species in Brazil (Landrum & Kawasaki 1997), and is characterized by flowers with well developed calyx tubes, bilocular ovaries with two ovules per locule and seeds with two plano-convex cotyledons, without visible hypocotyl.

3.1 Plinia espinhacensis Sobral, sp. nov. (**Figs. 19–20**). Type: BRAZIL. Minas Gerais. mun. Rio Vermelho: Serra do Ambrósio, 10 Jan 2006, *Viana et al. 2403* (holotype: BHCB).

Species haec *Plinae complanatae* proxima, a qua ramis cylindricis, petiolis minoribus distincta est.

Tree to 5 m. Twigs cylindrical or subcylindrical, with simple, erect brown or gray trichomes to 0.5 mm. Leaves petiolate, the petioles sulcate adaxially, 5–6 × 1.1–1.8 mm, with trichomes as the twigs; blades lanceolate, 75–155 × 30–50 mm, 2.5–3 times as long as wide, concolorous or slightly discoloured in dried specimens, the adaxial surface somewhat lustrous, glabrous or with trichomes to 0.5 mm along the midvein, the abaxial surface dull, with scattered erect, simple trichomes 0.5–0.8 mm, intermixed with occasional dibrachiate trichomes with unequal branches to 0.5 mm; glands barely visible abaxially, about 10 per square milimeter and less than 0.1 mm in diameter; apex acute or acuminate, with an acumen to 10 mm; base acute; midvein sulcate adaxially and markedly salient abaxially; lateral veins 15–25 pairs, evident and moderately salient on both sides, diverging from the midvein in angles of 60–70 degrees, with thinner secondary lateral veins; marginal vein 1–1.5 mm from the occasionally revolute margin. Inflorescences paniculiform, axillary or in aphyllous brachyblasts, with gray erect trichomes to 0.2 mm, with up to 30 flowers, the main fertile axis 50–70 × 1–1.5 mm at the first branching, branched once or twice, the proximal ones 20–30 mm; occasionally the inflorescence is reduced either to a single, racemiform or even uniflorous structure, with fertile axes to 10 mm bearing 3–4 series of triangular hypsophylls 0.7–1 × 0.7–0.8 mm; bracts triangular, 1.3–1.5 × 1.2–1.5 mm; pedicels absent or to 1.5 × 1 mm; bracteoles triangular, 1–1.8 × 0.8–1 mm, with cilia to 0.2 mm; flower buds globose to ellipsoid, 4–5 × 3 mm, uniformly covered with gray trichomes to 0.2 mm; calyx lobes 4, hemispheric or widely triangular, sometimes of two distinct sizes, 1–2 × 1.5–2 mm, glabrous or scarcely pilose internally; petals rounded or oblate, chartaceous, 2–2.2 × 2.5–2.8 mm, externally with trichomes to 0.1 mm and venation scarcely visible; stamens ca. 90. 6–7 mm, the anthers globose or oblate, 0.3–0.4 × 0.3 mm, without visible glands; staminal ring to 3 mm in diameter; hypanthium 1–1.5 mm deep; style 7–8 mm; stigma punctiform and papillose; ovary bilocular, with 2 ovules per locule. Fruits unripe, elliptic, 7–8 × 5 mm, 8-ridged longitudinally, 1-seeded; embryo with two distinct plano-convex cotyledons, without visible hypocotyl.

Habitat, distribution and phenology.—This species is a tree from montane gallery forests or dry forests ("carrascos") from the Espinhaço Range in central Minas Gerais, growing at altitudes from 1000 to 1400 m. It is presently known from two municipalities Flowers were collected in October and January and unripe fruits in November. Curiously, the flowers present a strong scent of cooked beans (R. Mota and P. Viana, pers. comm.).

Conservation.—*Plinia espinhacensis* is known for two localities distant about 300 km from each other, but there is neither information relative to the condition of its habitat nor about the occurrence of the species along this range. So, this species can be considered as data deficient (DD), since IUCN (2001) suggests this status when "there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status."

Affinities.—This species is close to *Plinia complanata* M.L.Kawasaki & B.Holst, described for the Brazilian atlantic coastal forest, from which it is kept apart by the characters in the following couplet:

1. Branches evidently flattened; petioles to 10 mm; coastal atlantic forests of the state of São Paulo ____**Plinia complanata**
1. Branches cylindrical; petioles to 6 mm; montane gallery forests from the Espinhaço Range at the state of Minas Gerais ____**Plinia espinhacensis**

Etymology.—The epithet refers to the central mountainous massif that extends from central to northern Minas Gerais, the Serra do Espinhaço (Rapini et al. 2001), where the two collection sites are included.

Paratypes. **BRAZIL. Minas Gerais. Mun. Conceição do Mato Dentro:** Parque Natural Municipal do Ribeirão do Campo, 28 Oct 2003, *Mota et al. 3151* (BHCB); 14 Nov 2003, *Mota et al. 3150* (BHCB).

ACKNOWLEDGMENTS

To the staff of the herbaria cited, for their constant good will in sending duplicates and helping in many other respects; to the many collectors of the exsiccates studied here; to André Amorim (CEPEC) for his fortunate suggestion for naming *Myrcia pendula* and to Luiz Antônio Cestaro (UFRN), for his kind help and friendship during my stay in Natal looking for *Eugenia azeda*; to Rafaela Forzza and Erika von Sohsten Medeiros, from RB, for their valuable help in the preparation of the images. Although not participating directly in this paper, I am very indebted to Eve Lucas (K), Fiorella Mazine (ESA), and Marcelo Souza (R), for sharing their knowledge of Myrtaceae and their opinions with me. I am also indebted to Barney Lipscomb (BRIT) and Leslie Landrum (ASU), who improved this paper with their careful revisions and kindly correcting my English.

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REVISION OF *LOBELIA* SECT. *SPEIREMA* (CAMPANULACEAE: LOBELIOIDEAE)

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ABSTRACT

Lobelia sect. **Speirema,** endemic to southeastern Asia, is a group of large lax perennial herbs with solitary axillary flowers, sub-bilabiate corolla, baccate fruit, and reticulate seeds. Study of morphological characters in a set of representative and type specimens supported recognition of *L. fangiana*, *L. longipedicellata*, and *L. montana*, but not *L. brevisepala*, *L. reflexisepala*, or *L. wardii*; these last three are treated here as synonyms of *L. montana*. In addition, *L. deleiensis* is resurrected from the synonymy of *L. montana*, as it may be distinguished by a suite of floral characters that is assumed to confer reproductive isolation.

RESUMEN

Lobelia sect. **Speirema,** endémica del sureste de Asia, es un grupo de hierbas perennes grandes y laxas con flores solitarias axilares, corola sub-bilabiada, fruto baccáceo, y semillas reticuladas. El estudio de caracteres morfológicos en un conjunto de especimenes representativos y tipos permite el reconocimiento de *L. fangiana*, *L. longipedicellata*, y *L. montana*, pero no de *L. brevisepala*, *L. reflexisepala*, o *L. wardii*; estas tres últimas se tratan aquí como sinónimos de *L. montana*. Además, *L. deleiensis* se resucita de la sinonimia de *L. montana*, ya que puede distinguirse por un conjunto de caracteres florales que se asume que le confieren aislamiento reproductivo.

INTRODUCTION

The 415 species assigned to *Lobelia* L. (Lammers 2007a, 2010) make it the largest of the 29 genera in the Campanulaceae subfamily Lobelioideae (Lammers 2007b). Its infrageneric classification was revised recently (Lammers 2010), with recognition of 18 sections. Among those newly recognized was *L.* sect. *Speirema*, to which were assigned five species of southeastern Asia: *L. brevisepala*, *L. fangiana*, *L. longipedicellata*, *L. montana*, and *L. reflexisepala*. In the course of treating these species for the *Flora of China*, problems were encountered with their circumscription and characterization. As a result, this taxonomic revision was undertaken, the fourth in a series of such accounts for sections of *Lobelia* (Lammers 2000, 2004, 2007c).

TAXONOMIC HISTORY

The type of *Lobelia* sect. *Speirema* is *L. montana*, which was published in 1826 by Carl Ludwig Blume, director of the Buitenzorg Botanic Garden at what is today Kota Bogor, Indonesia. The species' description was drawn up from specimens collected in the mountains of Java by the garden's founder, Caspar Reinwardt. Blume's diagnosis was woefully brief, describing only the branched procumbent stems, serrate leaves, and solitary axillary flowers; no mention was made of the size of the plant, details of the flowers, or fruit type. As a result of this brevity, the species remained poorly known for some time. It was not mentioned at all by Don (1834) or Presl (1836), while Candolle (1839) was obliged to list it among "species minus notae aut generis dubii." Generic placement remained contentious and the species would peregrinate among four other genera before finally coming home to *Lobelia*.

In 1844, Justus Hasskarl, the assistant curator of Buitenzorg, reassigned *Lobelia montana* to the genus *Pratia* Gaudich. Though he did so without comment, one assumes that he had observed (either in nature or in cultivation) that the fruit was baccate rather than capsular, as this was the main distinction between *Pratia* and *Lobelia*.

Within *Pratia*, Hasskarl specifically assigned this species to an unranked taxon, *Bernonia* Endl. (Endlicher 1838; Brizicky 1969), which comprised Asian members of the genus with a bilabiate corolla. Meisner (1839) segregated this taxon from *Pratia* and accorded it generic rank as *Bernonia* (Endl.) Meisn.; however, no species-rank combinations were ever effected under this name. Candolle (1839) felt it inappropriate for

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two genera to commemorate a single person (the honoree of both *Pratia* and *Bernonia* was a French naval officer named Prat-Bernon), so he substituted the name *Piddingtonia* A. DC. for the latter. As Candolle was unsure of the identity and generic placement of *Lobelia montana* (see above), it remained for Friedrich Miquel in 1857 to transfer that species to *Piddingtonia*. At the same time, he described a related species from Java, *P. patens*, and two years later, Hasskarl added another, *P. cyanocarpa*. The name *Piddingtonia* is illegitimate under Art. 52.1 (McNeill et al. 2006), and subsequent authors treated it as a synonym of *Pratia* (Bentham 1876; Baillon 1885; Hemsley 1886; Schönland 1889; Wimmer 1943).

About this same time, Joseph Dalton Hooker and Thomas Thomson were "obliged to found a new genus [that they named *Speirema*] upon a remarkable and handsome species from the Sikkim Himalaya," which they took to be conspecific with ("nullo modo differt") *Lobelia montana* of distant Java. The authors did not articulate exactly why this species could not be accommodated in *Pratia* or *Piddingtonia*, but one assumes it was largely a matter of habit. While their plant was a tall herb with divaricate branches a foot long, all other species then assigned to *Piddingtonia* and *Pratia* (cf. Hooker 1844, 1852) were much smaller plants with prostrate or decumbent stems. However, recognition of *Speirema* did not extend beyond the initial publication. Bentham (1876) discussed it briefly under *Pratia*, commenting that it differed solely by its taller habit and larger flowers. Baillon (1885) agreed and demoted it to sectional rank, a classification adopted by Hemsley (1886) and Schönland (1889).

In his monograph, Wimmer (1943, 1953, 1968) divided *Pratia* into two sections: *P.* sect. *Pratia* (including *Piddingtonia*) for the small usually prostrate or decumbent species, and *P.* sect. *Colensoa* (Hook. f.) Baill. (including *Speirema*) for the tall usually ascending or erect species. The latter section included not only the types of *Speirema* and *Colensoa* Hook. f. [*P. physaloides* (A. Cunn.) Hemsl. of New Zealand], but an additional ten baccate species of similar habit from southeastern Asia and the Neotropics.

Because the fleshy fruit of *Pratia* was the sole feature that consistently distinguished the genus from *Lobelia*, a given species of *Pratia* often had more in common with certain species of *Lobela* than it did with congeners. Such patterns often are an indication that the one genus is polyphyletic, stemming from disparate elements of the other. Consequently, taxonomists in the mid-Twentieth Century (summarized by Lammers 1993) began to question the wisdom of recognizing *Pratia*. This movement began with regional authors transferring their species of *Pratia* to *Lobelia;* Moeliono (1960) did so for the Asian species, including *L. montana*. Eventually, the two genera were fully merged by Murata (1995) and Lammers (1998). Wimmer's *Pratia* sect. *Pratia* became *Lobelia* sect. *Pratia* (Gaudich.) J. Murata [assigned to L. subg. *Mezleria* (C. Presl) E. Wimm.], while *P.* sect. *Colensoa* became *L.* sect. *Colensoa* (Hook. f.) J. Murata [assigned to L. subg. *Tupa* (G. Don) E. Wimm.]. Baccate fruit was no longer a distinguishing character, as each section also included capsular species.

In the most recent revision of *Lobelia* (Lammers 2010), *L.* sect. *Colensoa* was pared down to its type, *L. physaloides*. Most of the other species placed there by Wimmer and Murata were reassigned to *L.* sect. *Rhynchopetalum* (Fresen.) Benth. and *L.* sect. *Tylomium* (C. Presl) Benth., while *L. borneensis* (Hemsl.) Moeliono was segregated as *L.* sect. *Plagiobotrys* Lammers. *Lobelia montana* and four similar Asian species (*L. brevisepala*, *L. fangiana*, *L. longipedicellata*, and *L. reflexisepala;* cf. Lammers 2007a) then became *L.* sect. *Speirema*.

MATERIALS AND METHODS

Morphological data were gathered from approximately 150 specimens (including types) deposited in 15 herbaria (see Acknowledgments) and analyzed via traditional taxonomic methodology (Leenhouts 1968; Qualls 1986; Vogel 1987; Maxted 1992; Watson 1997; Winston 1999). Once taxa had been discerned in this fashion, they were compared to type specimens to determine the correct name under the *International Code of Botanical Nomenclature* (McNeill et al. 2006). Decisions on rank for the taxa were made in light of the definitions of species and subspecies I have employed previously (e.g., Lammers 1991, 2005, 2007a).

RESULTS AND DISCUSSION

This study supports the continued recognition of only three of the five species originally assigned to *Lobelia* sect. *Speirema* (Lammers 2010): *L. fangiana*, *L. longipedicellata*, and *L. montana*. *Lobelia brevisepala* and *L. reflexisepala* are here added to the synonymy of the last for the following reasons. First, the calyx lobe features used to distinguish them from sympatric *L. montana* are not likely to function in the enforcement of reproductive isolation. Second, these features are merely extremes in a continuum of variation; there are no gaps in the range of calyx lobe lengths nor in their posture. In fact, although widely distributed species often evince geographically correlated patterns of variation that make the recognition of subspecies possible, such was not the case with *L. montana* (cf. Barnesky & Lammers 1997; Thompson & Lammers 1997). The geographic origin of a specimen cannot be predicted on the basis of morphology.

This study also revealed that *Lobelia deleiensis*, treated as a synonym of *L. montana* (Haridasan & Mukherjee 1988; Lammers 2007a), differs consistently from that species in size of the corolla and staminal column and in color of the anther tube. Among Lobelioideae, differences of this sort often are correlated with pollinator differences and thus may be indicative of reproductive isolation (Wood 1961; Young 1982; Lammers & Freeman 1986; Lammers 1991, 1995, 2000, 2009; Sazima et al. 1994; Thompson & Lammers 1997; Muchhala 2003, 2006). For this reason, *L. deleiensis* is here accorded specific rank.

TAXONOMY

Lobelia sect. **Speirema** (Hook. f.) Lammers, comb. nov. *Speirema* Hook. f. & Thomson, J. Proc. Linn. Soc., Bot. 2:27. 1858. *Pratia* sect. *Speirema* (Hook. f.) Baill., Hist. Pl. 8:366. 1885. Type [sub Art. 37.3]: *Speirema montanum* (Reinw. ex Blume) Hook. f. & Thomson.

Lobelia subsect. *Haynaldianae* E. Wimm., Ann. Naturhist. Mus. Wien 56:366. 1948. Type [designated by J. Murata, J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot. 15:358. 1995.]: *Lobelia omeiensis* E. Wimm. Although Mabberley (1974) earlier designated *L. fistulosa* Vell. to stand as the type, so that this name might be applied to the Brazilian members of *L.* sect. *Rhynchopetalum* (cf. Lammers 2010), that species was not among those included in the protologue.

Plants perennial (hemicryptophytes or chamaephytes; *L. deleiensis* a rhizomatous geophyte), 0.3–2 m tall, terrestrial. Stems herbaceous or suffruticose, 2–8 mm diam., branched (commonly from base and sometimes above) or unbranched, erect, ascending, arching, or sprawling, glabrous (rarely scabrous or puberulent); latex acrid, viscous, white. Leaves alternate, simple, exstipulate, dorsiventral, pinnately veined (dillenid), petiolate (sessile in *L. fangiana*); lamina elliptic, oblong, lanceolate, oblanceolate, or ovate, chartaceous or subcoriaceous (fleshy in *L. longipedicellata*), glabrous (rarely puberulent when young, or sparsely scabrous on midrib below); margin callose-toothed, flat (revolute in *L. longipedicellata*); apex caudate, cuspidate, or acuminate; base rounded, obtuse, cuneate, or rarely attenuate; petiole (when present) winged, much shorter than the blade. Flowers tetracyclic, perfect, zoophilous, chasmogamous with a specialized method of proterandrous secondary pollen presentation, resupinate, epigynous, zygomorphic, pedicellate, solitary in the axils of little-reduced or unreduced leaves (in *L. fangiana* often supplemented by a terminal 10–25-flowered bracteate anauxotelic raceme); pedicels ascending, spreading, sigmoid, or incurved, ⅒–¾ as long as the subtending leaf or bract, glabrous or puberulous, ebracteolate (in *L. longipedicellata* often with a pair of linear bracteoles in the lower third). Calyx synsepalous, radially symmetric, adnate to the ovary, forming an appendicular hypanthium ⅙–½ as long as corolla, glabrous (sometimes the tube short-pubescent on the nerves); base acute, obtuse, or rounded; lobes 5, valvate, lanceolate, triangular, or linear, ⅘–3 times as long as the hypanthium, erect, spreading, recurved, or rarely reflexed, the margin entire (in *L. fangiana* sometimes with 1–3 teeth per side), flat (revolute in *L. longipedicellata*), the apex acute or acuminate. Corolla early-sympetalous, valvate, bilaterally symmetric, sub-bilabiate with 2 dorsal lobes and a trifid ventral lip, dark violet, red-purple, bluish lilac, greenish, or cream-colored, the lip often contrastingly marked; tube straight, cleft to its base on the dorsal side, about as long as broad to 4¼ times longer than broad, pubescent within and sometimes without; dorsal lobes linear, linear-spatulate, or linear-triangular, a little shorter than the tube to 4⅓ times longer than the tube, apex acuminate; ventral lobes connate for ⅕–¾ their length, free portion elliptic or lanceolate, apex caudate, acuminate, or acute. Stamens 5, antisepalous, connate distally, forming a dorsally deflected staminal column exserted from the dorsal slit of corolla and free from the corolla tube; filament tube glabrous or pubescent; anthers tetrasporangiate, dithecal, basifixed, introrsely dehiscent by longitudinal slits, the dorsal three longer than the ventral two, forming a ventrally oblique gray or cream-colored tube occluded at the orifice, its dorsal surface glabrous or sparsely short-pubescent toward apex; dorsal anthers ⅖–1¼ times as long as the filament tube; ventral anthers bearded at apex with tufts of white filiform hairs; pollen grains tricolporate or tricolpate, prolate, ellipsoid, psilate. Gynoecium syncarpous, bilocular; ovary inferior; placentae axile, large; ovules numerous, small, anatropous, unitegmic, tenuinucellate; style solitary, slender, terete, with a ring of stiff white hairs below the apex; stigma bilobed, the lobes appressed and non-receptive as the style grows through the anther tube, pushing out pollen, after which the stigmas spread and become receptive. Fruit a black-purple to violet or greenish globose or obovoid berry. Seeds small, numerous, amber-colored or tan, broadly ellipsoid, subterete to slightly compressed or sometimes angular; testa striate-reticulate (Murata Type C), shiny or dull. Chromosome number unknown (Lammers 1993).

Distribution.—Endemic to southeastern Asia, from northeastern India and southwestern China to northern Vietnam, with disjunct populations of *Lobelia montana* on the Malay Peninsula, Sumatra, and Java.

KEY TO THE SPECIES OF *LOBELIA* SECT. *SPEIREMA*

1. Lamina fleshy, the margin revolute; pedicels 38–80 mm long, often with a pair of linear bracteoles 6–18 mm long in the lower third; calyx lobes 2.5–5 mm wide, the margin revolute (NE India) **4. Lobelia longipedicellata**

1. Lamina chartaceous or subcoriaceous, the margin flat; pedicels 10–55 mm long, ebracteolate; calyx lobes 0.5–1.9 mm wide, the margin flat.

  2. Plants rhizomatous; corolla 12–18 mm long, tube 3–6 mm long; filament tube 6.5–8 mm long; anther tube cream-colored, the dorsal anthers 6–8 mm long, a little shorter to a little longer than the filament tube (NE India & SW Yunnan) **3. Lobelia deleiensis**

  2. Plants lacking rhizomes; corolla (15–)18–26 mm long, tube 6–13 mm long; filament tube 8.5–12 mm long; anther tube gray, the dorsal anthers 4.8–7 mm long, 2/5–¾ as long as the filament tube.

    3. Stems sparsely to densely puberulent toward apex; leaves sessile; uppermost 10–25 flowers often subtended by bracts only ¼–1/10 as long as the foliage leaves, thus forming a terminal raceme; pedicels densely puberulous; hypanthium pubescent along the nerves; calyx lobes narrowly triangular or triangular, 1.2–1.9 mm wide, erect; corolla greenish with purple spots on lip; anther tube 1.4–1.8 mm diam, glabrous; trichomes at apex of ventral anthers 0.5–1 mm long (S Sichuan) **1. Lobelia fangiana**

    3. Stems glabrous (rarely sparsely scabrous); leaves petiolate; all flowers subtended by unreduced foliage leaves; pedicels glabrous; hypanthium glabrous; calyx lobes linear or linear-triangular, 0.5–1.4 mm wide, ascending, spreading, or recurved; corolla dark violet or purple to bluish lilac, the lip often paler, or striped or blotched with white; anther tube 2–2.8 mm diam, its dorsal surface sparsely short-pubescent at least toward apex; trichomes at apex of ventral anthers 1–2 mm long (NE India & SW China to Java) **2. Lobelia montana**

1. Lobelia fangiana (E. Wimm.) S.Y. Hu, J. Arnold Arbor. 61:90. 1980. *Pratia fangiana* E. Wimm., Repert. Spec. Nov. Regni Veg. 38:3. 1935. TYPE: CHINA. SICHUAN: [Omei-hsien, Mt. Omei, grassy slope, 8500–9000 ft, 12 Aug] 1928, *Fang 2853* (HOLOTYPE: NY! ISOTYPES: E! K!). The information in brackets is found only on the isotypes.

Lobelia omiensis E. Wimm., Ann. Naturhist. Mus. Wien 56:366. 1948. TYPE: CHINA. SICHUAN: Mt. Omi, *Wilson 5034* (HOLOTYPE: K!).

Stems 0.7–1.5 m tall, 4–8 mm diam., unbranched, erect, sparsely to densely puberulous toward apex. Leaves sessile; lamina elliptic, narrowly elliptic, narrowly oblong, or lanceolate, 5.5–16 × 1.2–3 cm, chartaceous or subcoriaceous, glabrous; margin callose-serrulate or rarely callose-crenulate; apex acuminate; base cuneate. Flowers solitary in the axils of little-reduced or unreduced leaves, and the uppermost 10–25 often aggregated into a terminal raceme; bracts of the latter lanceolate or narrowly elliptic, 8–45 × 1.2–9 mm, glabrous, the margin callose-denticulate, the apex acuminate; pedicels 12–38 mm long, ascending or spreading, equaling to ½ as long as its subtending bract, or ¼–⅒ as long as its subtending leaf, densely puberulous, ebracteolate. Hypanthium obconic or campanulate, 3–5(–7) × 3–5 mm, (⅙–)⅕–⅖ as long as corolla, short-pubescent on the nerves or sometimes glabrous; base acute or obtuse. Calyx lobes narrowly triangular or triangular, 3–7 × 1.2–1.9 mm, equaling to ½ again as long as the hypanthium, erect; margin entire or with 1–3 teeth per side; apex acuminate. Corolla red-purple or greenish with the lip purple-spotted, 18–23 mm long; tube 6–10 × 2.2–3.5 mm, 1¾–3¾ times longer than broad, sparsely pubescent within and without; dorsal lobes linear or linear-triangular, 10–14 × 0.5–1.5 mm, equaling to 2¼ times longer than the tube, apex acuminate; ventral lobes 8–11 × 1.5–2.8 mm, connate for ⅓–½ their length, the free portion lanceolate, apex acuminate. Filament tube 8.5–12 mm long, glabrous; anther tube gray, 1.4–1.8 mm diam., its dorsal surface glabrous; dorsal anthers 5–6 mm long, ½–⅔ as long as the filament tube; ventral anthers 4–4.7 mm long, bearded at apex with tufts of white hairs 0.5–1 mm long. Berry globose or obovoid, 7–17 × 8–12 mm. Seeds amber-colored, broadly ellipsoid, subterete, 0.6–0.7 × 0.3–0.4 mm; testa dull.

Distribution, habitat and phenology.—Endemic to south-central Sichuan, China. Moist thickets on slopes and riverbanks, 1750–2745 m. Flowering and fruiting August to September.

Icones.—Wimmer (1943), fig. 29j [as *Pratia fangiana*]; Wimmer (1953), fig. 99e [as *Lobelia omiensis*]; Murata (1995), figs. 62–63.

Vernacular name.—Chinese: e mei zi chui cao.

Discussion.—The sessile leaves of *Lobelia fangiana* as well as its tendency to produce a terminal raceme are not found in any other member of *L.* sect. *Speirema*. These features are, however, characteristic of *L.* sect. *Rhynchopetalum* (Fresen.) Benth., a taxon well represented in southeastern Asia (Lammers 2010), and *L. fangiana* may represent an early stage in the divergence *L.* sect. *Speirema* from *L.* sect. *Rhynchopetalum*. It is assigned here on the basis of its baccate (vs. capsular) fruit and terete non-winged (vs. lenticular winged) seeds.

Because the type of *Lobelia omiensis* lacked fruit, Wimmer did not compare it to the baccate *Pratia fangiana* that he had described from the same locality 13 years earlier. Instead, he described the new species as intermediate between (though not likely a hybrid of) *L. davidii* Franch. and *L. nicotianiifolia* Roth ex Schult., species currently assigned to *L.* sect. *Rhynchopetalum* (Lammers 2010). It was Hu (1980) who studied the relevant type material as well as subsequent collections from Omei-shan and realized that the two names denote a single species. That conclusion was supported in the present study.

Representative specimens: **CHINA. Sichuan:** Qinglongzui near site of Longwangmiao along the Longxi River, *Boufford et al. 24773* (CAS); Mt. Emei, Xixiang Lake, *Guan et al. 04120* (MO); Mt. Omei, *Yin 127* (US); Dujiangyan, Longxi-Hongkou National Nature Preservation Area, Mt. Guangguang, *Zhu et al. 930* (MO, OSH).

2. **Lobelia montana** Reinw. ex Blume, Bijdr. 728. 1826. *Pratia montana* (Reinw. ex Blume) Hassk., Cat. Hort. Bot. Bogor. 106. 1844. *Piddingtonia montana* (Reinw. ex Blume) Miq., Fl. Ned. Ind. 2:573. 1857. *Speirema montanum* (Reinw. ex Blume) Hook. f. & Thomson, J. Proc. Linn. Soc., Bot. 2:27. 1858. Type: INDONESIA. Java: *Reinwardt s.n.* (lectotype, here designated: L-0001668! isolectotypes: L-0001686! L-0001689! NY!).

Piddingtonia patens Miq., Fl. Ned. Ind. 2:573. 1857. Type: "Java, op den G. Praoe (Horsf.)," not located.

Piddingtonia cyanocarpa Hassk., Bonplandia 7:179. 1859. *Pratia montana* var. *cyanocarpa* (Hassk.) E. Wimm., Pflanzenr. IV.276b:117. 1943. Type: not indicated.

Pratia montana f. *variegata* Hochr., Candollea 5:293. 1934. Type: INDONESIA: Java: Mt Salak versant W. au-dessus de Gœnœng boender, forêt, rives du Tjigamea, 1250 m, 2 Oct 1904, *Hochreutiner 1953* (holotype: G; isotype: L!).

Lobelia wardii C.E.C. Fisch., Bull. Misc. Inform. Kew 1940:298. 1941. *Pratia wardii* (C.E.C. Fisch.) E. Wimm., Pflanzenr. IV.276c:833.1968. Type: INDIA. Arunachal Pradesh: Delei Valley, 28°21'N 96°37'E, growing on the edge of thickets in the undergrowth, 5000 ft, 12 Jul 1928, *Kingdon Ward 8445* (holotype: K! isotype: K!).

Pratia reflexa Y.S. Lian, Acta Phytotax. Sin. 17:123. 1979. *Lobelia reflexisepala* Lammers, Novon 8:34. 1998. Non *Lobelia reflexa* Stokes, Bot. Mat. Med. 1:342. 1812. Type: TIBET: Mo Tuo, 2700 m, *Qinghai-Xizang Exped. Team 74-3970* (holotype: PE).

Pratia brevisepala Y.S. Lian, Fl. Reipubl. Popul. Sin. 73(2):189. 1983. *Lobelia brevisepala* (Y.S. Lian) Lammers, Novon 8:34. 1998. Type: CHINA. Yunnan: Xichou, 1500–1600 m, *Feng 11936* (holotype: PE).

Stems 0.5–2 m tall, 2–7 mm diam., commonly branched from base and sometimes above, erect, arching, sprawling, glabrous (rarely sparsely scabrous, or puberulent when young). Leaves petiolate; lamina elliptic, lanceolate, or ovate, 3.5–13 × 1.2–4.6 cm, chartaceous, glabrous (rarely puberulent when young, or sparsely scabrous on midrib); margin callose-serrulate, callose-denticulate, or callose-crenulate; apex caudate or sometimes merely acuminate; base cuneate, obtuse, or rounded; petiole 3–13 mm long. Flowers solitary in the axils of little-reduced or unreduced leaves; pedicels 24–55 mm long, ascending, spreading, sigmoid, or incurved, ⅕–¾ as long as its subtending leaf, glabrous, ebracteolate. Hypanthium globose or campanulate (rarely obconic), 3–6 × 3–5 mm, ⅙–3⁄10 as long as corolla, glabrous; base obtuse or rounded (rarely acute). Calyx lobes linear-triangular or linear, 2–14 × 0.5–1.4 mm, ⅘–2⅔ times as long as the hypanthium, spreading, recurved, or rarely reflexed; margin entire; apex acuminate. Corolla dark violet to bluish lilac, the lip often paler, or striped, margined, or blotched with white, 15–26 mm long, long–pubescent within; tube 6–13 × 2.5–4 mm, 1¾–4¼ times longer than broad; dorsal lobes linear, 9–17 × 0.9–1.2 mm, equaling to 2¾ times longer than the tube, the apex acuminate; ventral lobes 7–15 × 2–5 mm, connate for ⅕–⅗ their length, the free portion elliptic, apex caudate. Filament tube 9–12 mm long, glabrous; anther tube light gray, 2–2.8 mm diam., its dorsal surface sparsely short-pubescent at least toward apex; dorsal anthers 4.8–7 mm long, ⅖–¾ as long as the filament tube; ventral anthers 3.8–6 mm long, bearded at apex with tufts of white hairs 1–2 mm long. Berry violet to black-purple, globose, 6–15 × 7–19 mm. Seeds amber-colored, broadly ellipsoid, slightly compressed, 0.5–0.8 × 0.3–0.5 mm; testa shiny.

Distribution, habitat and phenology.—In three disjunct areas in southeastern Asia; the first overlaps the geographic distribution of *Lobelia deleiensis* and *L. longipedicellata*. *(1)* Northeastern India (Arunachal Pradesh) and Tibet to northeastern Burma. Thickets and openings in wet broadleaf and evergreen cloud forests at 1300–2135 m. Flowering July through November, fruiting August through April. *(2)* Southeastern Yunnan and northern Vietnam. Thickets and openings in wet broadleaf and evergreen cloud forests at 1300–2135 m. Flowering July through November, fruiting August through April. *(3)* The Cameron Highlands of the Malay Peninsula, and the Indonesian islands of Sumatra and Java. Wet montane rain and cloud forests, subalpine scrub forest, and meadows at 1000–3000 m. Flowering and fruiting primarily during the monsoon seasons: December through April and July through September. Map: Moeliono (1960), fig. 18 (solid line).

Icones.—Moeliono (1960), fig. 17; Wimmer (1968), fig. 14b [as *Pratia wardii*]; Academia Sinica (1979), fig. 153 1–2 [as *P. montana*]; Lian (1979), fig. 2 [as *P. reflexa*]; Lian (1983), pg. 170 [as *P. brevisepala*], pg. 172 [as *P. reflexa*]; Lian (1985), fig. 266 [as *P. reflexa*]; Haridasan & Mukherjee (1988), fig. 13; Murata (1992) figs. 25, 35, 39–40.

Vernacular names.—Chinese: shan zi chui cao. Indonesian: hi-leuntja. Sundanese: djanghe leuweung, djonghe rende.

Discussion.—Although type material of Javanese *Piddingtonia cyanocarpa* and *P. patens* was not available for study, these names are included in synonymy with confidence, following Moeliono (1960). Both were compared to *P. montana* by their authors, and in neither case have the alleged distinctions from that species held up following examination of a far larger body of material. As such, they are a parallel case to the synonymization of Chinese *Lobelia brevisepala* and *L. reflexisepala* (see above).

The name *Pratia montana* f. *variegata* was bestowed on plants with distinctive bicolorous corolla pigmentation. Judging from collectors' notes on specimens, floral color is quite variable within *Lobelia montana*, and as the observed variation is not correlated with geography nor with other morphological features, it does not merit nomenclatural recognition.

The type specimen of *Lobelia wardii* lacked fruit and so the possibility of a relationship to *L. montana* was not perceived by its author. Instead, it was compared (as were *L. deleiensis* and *L. longipedicellata*) to *L. erectiuscula* H. Hara, a species of *L.* sect. *Rhynchopetalum*. It was Wimmer (1968) who, in transferring the species to *Pratia*, first noted that it was very similar to *P. montana*. He nonetheless retained it as a distinct species by virtue of the peculiar ("eigentümliche") ventral lip of its corolla, though it is difficult to detect anything in his description of the novelty that differs from his earlier description of *P. montana* (Wimmer 1943). Haridasan and Mukherjee (1988) treated the name as a synonym of *P. montana*, commenting that "the distinguishing characters are too meagre." The present study supported their conclusion; the type of *L. wardii* could be matched by any number of specimens confidently assigned to *L. montana*.

Representative specimens. **INDIA. Arunachal Pradesh:** Mishme, *Griffith 3442* (K); Subansiri, 1 mi from Sayata, *Sastry 40782* (L). **BURMA. Kachin:** Htawgaw, *Forrest 24854* (K, US), *Forrest 24890* (US). **CHINA. Yunnan:** Mengtze [Mengzi], SW mts., *Henry 9370A* (E

MO, US), *Henry 9370B* (K, NY). **VIETNAM. Lào Cai:** Env. du Cha-pa [Sa Pa], Apr 1909, *d'Alleizette s.n.* (L); Hoang Lien National Park, trail to Phang Xi Pang peak, *Atha et al. 4867* (BRIT, NY); Lo Qui Ho, environs de Chapu [Sa Pa], *Petelot 5097* (NY, US). **Hà Giang:** Vi Xuyen, Cao Bo, Tam Ve, *Harder et al. 5424* (MO). **Cao Bằng:** Nguyen Binh, ca. 41 km W of Cao Bằng, *Averyanov et al. CBL 037* (MO), *Averyanov et al. CBL 202* (MO). **MALAYSIA. Pahang:** Mt. Brinchang, 47 mi. from Tapah, *Abbe & Abbe 10287* (K, NY); Gunong Brinchang, *Chew 920* (K, L); Cameron Highlands, *Henderson 23296* (K, NY); Brinchang Mt., *Klackenberg & Lundin 748* (S); between Gunong Brinchang and Green Cow Area, *Shimizu et al. 13453* (L); Gunong Batu Brinchang, roadside above ¼ mi from summit, *Sinclair 9953* (L, NY); Gunong Brinchang, *Turnau 802* (K); Gunong Brinchang, W of Tanah Rata, *Woods et al. 682* (L); Gunong Brinchang, *Worthington 12635* (BRIT, L, NY). **INDONESIA. Sumatra:** Tapanuli, near Baniara, S of Sidikalang, *Alston 15040* (L); trail from Medan Road to top of Sibajak volcano, *Bangham & Bangham 1054* (K, NY); Karoland, Dĕlĕng Si Bajak, *Bartlett 6513* (NY); Karoland, Dĕlĕng Si Naboen, *Bartlett 8625* (NY); Abita, Sul Me. Singalan, (alto Padang), *Beccari 53* (K, L); Toba, vicinity of Loemban Loboe, *Boeea 10415* (L); Asahan, Aek Si Oelak, *Boeea 11221* (L); G. Merapi, *Bünnemeyer 4577* (L); G. Falang, Pad Bovenlanden, *Bünnemeyer 5503* (L); G. Koerintji, *Bünnemeyer 9663* (L); G. Koerintji, *Bünnemeyer 10420* (K); Lae Pondom, 28 km E of Sidikalang, *Dunselman 9* (L); Sibajak, *Lörzing 13543* (L); Gunong Singgalan, 16 Jan 1913, *Matthew s.n.* (K); Mt. Kerintji, G. Tudjuh crater ridge, *Meijer 6564* (L); summit of Gunung Talang, Kabupaten Solok, *Nagamasu 3443* (L); Schagak volcano, Berastagi, 11 Feb 1921, *Ridley s.n.* (K); montis Singalang, *Schiffner 2727* (L), *Schiffner 2729* (L), *Schiffner 2734* (L); montis ignivomi Merapi, *Schiffner 2735* (L); summit of Mt. Goh Pemboek, *Steenis 9116* (L); Atjeh, Gajolanden Sanger Valley above Blang Kedjeren, *Steenis 9858* (L); W side Mt. Marapi, *Borssum Waalkes 2215* (L); Atjeh, Gunung Bandahara, ca. 25 km NNW of Kuktatjane, *de Wilde & de Wilde-Duyfjes 13303* (K, L); Gunung Batu Lopang, ca. 10 km ESE of Prapat (Lake Toba), *de Wilde & de Wilde-Duyfjes 13512* (L); Atjeh, Upper Mamas River, ca. 15 km W of Kutacane, *de Wilde & de Wilde-Duyfjes 19099* (L); east coast, *Yates 1503* (B, NY); Fort de Kock, Mt. Singgala, *Yates 2460* (B, NY). **Java:** Mt. Malabar, *Anderson 281* (K); Preanger, Papandajan oostzyde, *Backer 5527* (L); Preanger, Faloen, *Backer 5660* (L); Rantja Walini, *Backer 12584* (L); G. Gedeh boven Tjibodas, *Backer 13550* (L); Petaeng Kriånå, *Backer 15025* (L); Dieng plateau, *Backer 21673* (L); sine loc., s.d., *Blume s.n.* (NY); Preanger, Bosschen van Malabar, *Denker 22* (L); Tjibodas, Tjurug, Tjikundul, *Enoh 26* (L); Tjibeureum, Mt. Gede, *Forman 105* (K, L); slopes of Volcano Gedeh below Gedeh-Pangorango Saddle toward Tjibodas, *Fosberg 44642* (NY); mt Guedéh, en montant à Kandang badak, *Hochreutiner 1047* (L); Dieng, G. Prahoe, *Karsten 24* (L); Mt. Gedeh above Tjibodas, *Kern 8309* (L); G. Papandajan, Mar 1930, *Kjellberg s.n.* (S); Preanger, G. Papandajan, *Koorders 41300* (L); Gede, *Kuntze 4618* (NY); Dieng, *Kuntze 5701* (NY); Région de Bogor, Volcan Pangrango, *Lisowski 53241* (WAG); sine loc., 1846, *Lobb 107* (K); Tjibodas, Tjipanas, *Main 328* (K, L); Mt. Gede, Tjibeureum, *Meijer 1602* (L); G. Malabar, Poentjak gede, *Monterie 38* (L); Cibodas, pentes du Gunung Gedè, *Raynal 18905* (MO); Tjibodas, Kandang Badak, *Reijnvaan 37* (L); N side of Gedeh-Rangrango massif, 30 km SE of Bogor, *Sands 49* (K); Tjibodas, 27 Oct 1966, *Schwabe s.n.* (B); sine loc., s.d., *Siebold s.n.* (M); Dieng plateau, S of Sikidang crater, ca. 2 km S of Dieng, *Wieringa 1919* (K, WAG).

3. Lobelia deleiensis C.E.C. Fisch., Bull. Misc. Inform. Kew 1940:297. 1941. *Pratia montana* var. *deleiensis* (C.E.C. Fisch.) E. Wimm., Pflanzenr. IV.276c:833. 1968. Type: INDIA. Arunachal Pradesh: Delei Valley, 28°21'N 96°37'E, 6000–7000 ft, 16 Jul 1928, *Kingdon Ward 8460* (holotype: K-000575349! isotype: K-000575348!).

Rhizomatous perennial. Stems 0.5–2 m tall, 2.3–7 mm diam., often branched from base and sometimes above, erect or arching, glabrous. Leaves petiolate; lamina elliptic or lanceolate, 6–14 × 1.4–4.2 cm, chartaceous or subcoriaceous, glabrous; margin callose-denticulate, callose-serrulate, or callose-crenulate; apex caudate; base cuneate or obtuse; petiole 3–18 mm long. Flowers solitary in the axils of little-reduced or unreduced leaves; pedicels 16–45 mm long, sigmoid or incurved, ⅕–⅖ as long as its subtending leaf, ebracteolate. Hypanthium campanulate or obovoid, 4–7 × 4.5–8 mm, ¼–½ as long as corolla, glabrous; base obtuse or rounded. Calyx lobes linear or linear-triangular, 5–17 × 0.5–0.9 mm, equaling to 3 times longer than the hypanthium, spreading or recurved; margin entire; apex acuminate. Corolla cream-colored or greenish with purple or blue markings on lip, 12–18 mm long; tube 3–6 × 3–4 mm, about as long as broad to twice as long as broad, pubescent within; dorsal lobes linear or linear-spatulate, 9–14 × 0.8–1.5 mm, 1¾–4⅓ times longer than the tube, the apex acuminate; ventral lobes 8–11 × 1.5–2.7 mm, connate for ⅕–⅖ their length, the free portion narrowly elliptic, the apex caudate. Filament tube 6.5–8 mm long, glabrous or sparsely pubescent; anther tube cream-colored, 2.3–3 mm diam., its dorsal surface glabrous or sparsely short-pubescent toward apex; dorsal anthers 6–8 mm long, 7/8–1¼ times as long as the filament tube; ventral anthers 4–6 mm long, bearded at apex with tufts of white hairs 0.8–2 mm long. Berry greenish, globose, 8–11 × 9–12 mm. Seeds tan, broadly ellipsoid, slightly compressed, 0.6 × 0.4 mm; testa dull.

Distribution, habitat and phenology.—Northeastern India and southwestern Yunnan. Evergreen broadleaf forest, 1525–2440 m. Flowering July–November, fruiting August–April.

Icones.—Wimmer (1968), fig. 14a [as *Pratia montana* var. *deleiensis*].

Discussion.—As with *Lobelia wardii*, the type of *L. deleiensis* lacked fruit and was compared by its author to *L.* (sect. *Rhynchopetalum*) *erectiuscula* instead of *L. montana*. Again it was Wimmer (1968) who, in transferring the name to *Pratia*, first perceived a relationship, treating the taxon as *P. montana* var. *deleiensis*. Haridasan and Mukherjee (1988) did not recognize this variety, commenting that "the distinguishing characters are too meagre." However, this is not in fact the case. In this study, I examined numerous specimens from northeastern India and southwestern Yunnan that conform to the type of *L. deleiensis;* in fact, the specimens that inspired Hooker and Thomson (1858) to segregate *L. montana* as the genus *Speirema* were among them. Although Hooker and Thomson regarded these plants as identical to *L. montana* ("nullo modo differt"), they do differ by a suite of floral features that reasonably may be assumed to confer reproductive isolation (see above). For this reason, these plants are accorded specific rank.

One gathering from western Yunnan [*Forrest 25183*, E, K, US] deviates somewhat from the suite of features typical of *Lobelia deleiensis*, suggesting the possibility of introgression or incomplete divergence from *L. montana* and/or *L. longipedicellata*. Character states suggesting the influence of *L. longipedicellata* include the increasing length of the pedicels (up to 60 mm), the increasing diameter of the hypanthium (8–9 mm), the wider (1.5–1.7 mm) subulate calyx lobes, and the stouter corolla tube (length 1½–2¼ times width). Character states suggesting the influence of *L.montana* include the slightly longer corolla (19–20 mm), the stouter corolla tube mentioned previously, the longer filament tube (7–9 mm) equaling to 1/3 again as long as the dorsal anthers, and the larger berries (15–16 × 15–16 mm) containing larger seeds (0.7–0.8 × 0.4–0.5 mm).

Representative specimens: **INDIA. Sikkim:** "reg. temp.," *d'Alleizette 4260* (L); Rungjo, *Gamble 2325A* (K); "East Himalaya," *Griffith 3442* (P); "Regio temp.," s.d., *Hooker s.n.* (K, L, M, NY, S, US); Sinchul, *Kuntze 6706* (NY); above Rhikisum, *Lacaita 15846* (P); Toong, *Meebold 15808* (S); sine loc., *Native Collector 194* (M); sine loc., s.d., *Thomson s.n.* (L). **West Bengal:** Singmari, 14 Mar 1938, *Biswas s.n.* (US); Rungbee, *Clarke 8657* (K, L). **Nagaland:** Naga Hills, Pulebudze, *Bor 6361* (K). **Manipur:** "East Bengal," *Griffith 3442* (P); Sirhoi, *Kingdon Ward 17278* (NY). **CHINA. Yunnan:** Fugong Xian, Lishadi Xiang, Yaduo Cun, vicinity of Mabiluo, N fork of Yamu He, *Gaoligong Shan Biodiversity Survey 26788* (OSH); Fugong Xian, Lumadeng Xiang, Yaping Cun, below old Shibali , S fork of Yuma He, *Gaoligong Shan Biodiversity Survey 28725* (OSH), *Gaoligong Shan Biodiversity Survey 28799* (MO); Gongshan, Cikai Zheng, W of Gongshan along the Pula He between Qiqi bridge and Qiqi, *Li Heng 12178* (MO); Kiukiang-Taru divide, Lungnan, *Yü 20020* (E).

4. Lobelia longipedicellata C.E.C. Fisch., Bull. Misc. Inform. Kew 1940:298. 1941. *Pratia longipedicellata* (C.E.C. Fisch.) E. Wimm., Pflanzenr. IV.276c:833. 1968. TYPE: INDIA. ARUNACHAL PRADESH: Delei Valley, 28°21'N 96°37'E, 6000–8000 ft, on south-facing scarped bracken-clad slopes where it grows in clumps, 9 Jul 1928, *Kingdon Ward 8443* (HOLOTYPE: K-000575355! ISOTYPES: K-000575352! K-000575353! K-000575354!).

Stems 0.3–1 m tall, 4–8 mm diam., commonly branched from base and sometimes above, erect, glabrous. Leaves petiolate; lamina elliptic or narrowly elliptic (oblanceolate toward base of plant), 6–15 × 1.3–3.6 cm, fleshy, glabrous; margin revolute and minutely callose-denticulate or callose-serrulate; apex caudate or cuspidate, sometimes merely acuminate; base cuneate or attenuate; petiole 3–5 mm long. Flowers solitary in the axils of little-reduced or unreduced leaves; pedicels 38–80 mm long, sigmoid, ⅓–⅔ as long its subtending leaf, often bibracteolate in the lower third; bracteoles linear, 6–18 × 0.7–1.8 mm. Hypanthium obovoid or obconic, 5–9 × 5.5–7 mm, 3/10–½ as long as corolla, glabrous; base acute or obtuse. Calyx lobes narrowly triangular or lanceolate, 9–22 × 2.5–5 mm, 1¾–2½ times longer than the hypanthium, erect; margin entire, revolute; apex acute or acuminate. Corolla dark magenta, 14–18 mm long; tube 5–9.5 × 3 mm, 2⅔ times longer than broad, pubescent within; dorsal lobes linear-triangular, 8.5–12 × 0.7–0.9 mm, a little shorter than the tube to ½ again as long, apex acuminate; ventral lobes 9–10 × 3–3.3 mm, connate for ½–¾ their length, the free portion elliptic, apex acute. Filament tube 7–8 mm long, short-pubescent in lines; anther tube light grey, 2.5–2.8 mm diam., its surface glabrous; dorsal anthers 5–7 mm long, ⅘–9/10 as long as the filament tube; ventral anthers 4–5 mm long, bearded at apex with tufts of white hairs 0.5–1 mm long. Berry globose, 8–9 × 10–12 mm. Seeds amber-colored, broadly ellipsoid, angular, 0.5–0.6 × 0.3–0.4 mm; testa shiny.

Distribution, habitat and phenology.—Known only from the type.

Icones.—Wimmer (1968), fig. 14c [as *Pratia longipedicellata*].

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REVISION OF *LOBELIA* SECT. *PLAGIOBOTRYS* (CAMPANULACEAE: LOBELIOIDEAE)

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ABSTRACT

Lobelia sect. **Plagiobotrys** comprises large straggling or scrambling Malesian herbs and shrubs with elongate lateral racemes, bilabiate corolla, tufts of flattened trichomes at the apex of each anther, baccate fruit, and reticulate seeds. The type is *L. borneensis*, which is divided here into four allopatric subspecies: subsp. *borneensis* (Sarawak); subsp. **celebensis,** subsp. nov. (Sulawesi); subsp. **grandiflora,** comb. et stat. nov. (Sabah); and subsp. **insulae-florum,** subsp. nov. (Flores). Added to this is **L. origenes,** sp. nov., also from Sabah, but from higher elevations than *L. borneensis* subsp. *grandiflora*.

RESUMEN

Lobelia sect. **Plagiobotrys** comprende hierbas y arbustos grandes malesianos extendidas o reptantes con racimos laterales alargados, corola bilabiada, mechones de tricomas aplastados en el ápice las anteras, fruto baccáceo, y semillas reticuladas. El tipo es *L. borneensis*, que se divide aquí en cuatro subespecies alopátricas: subsp. *borneensis* (Sarawak); subsp. **celebensis,** subsp. nov. (Sulawesi); subsp. **grandiflora,** comb. et stat. nov. (Sabah); y subsp. **insulae-florum,** subsp. nov. (Flores). Se añade a esto **L. origenes,** sp. nov., también de Sabah, pero de mayores elevaciones que *L. borneensis* subsp. *grandiflora*.

INTRODUCTION

Lobelia L. is the largest of the 29 genera in the Lobelioideae (Campanulaceae) with over 400 species (Lammers 2007a, 2007b). Recently, I revised the infrageneric classification of the genus, recognizing 18 taxonomic sections (Lammers 2010a). Among those newly recognized was *L.* sect. *Plagiobotrys,* which contained but a single species, Malesian *L. borneensis*. However, in the course of examining representative material for that study, significant variation was noted among the exemplars of that species; this suggested that additional taxa referable to *L.* sect. *Plagiobotrys* might be lurking undetected and that further study was warranted. This research has been completed and its results presented here, as the fifth in a series of species-level accounts for the sections of *Lobelia*. Previous entries in the series covered *L.* sect. *Tupa* (G. Don) Benth. (Lammers 2000), *L.* sect. *Homochilus* A. DC. (Lammers 2004), *L.* sect. *Galeatella* E. Wimm. (Lammers 2007c), and *L.* sect. *Speirema* (Lammers 2010b).

TAXONOMIC HISTORY

The history of *Lobelia* sect. *Plagiobotrys* begins with the description of *Pratia borneensis* by William Botting Hemsley of the Royal Botanical Gardens, Kew. This name was based upon a specimen collected on Borneo in August 1884 by Singapore schoolmaster R. William Hullet, which was included among a group of 280 specimens sent to Kew a year later (van Steenis-Kruseman 1950). The species' assignment to *Pratia* Gaudich. was occasioned by its baccate fruit; at that time *Pratia* was distinguished from *Lobelia* on the basis of producing berries instead of capsules.

The new species differed from most species of *Pratia* (and *Lobelia*) in producing a terminal bracteate raceme that was soon overtopped by an adjacent axillary shoot, causing the inflorescence to appear to have arisen in a lateral position. The only other herbaceous lobelioid to possess this unusual combination of baccate fruit and lateral inflorescence was the New Zealand endemic *P. physaloides* (A. Cunn.) Hemsl. These two species were also much larger plants than most other *Pratia* (a meter tall or more). Consequently, Hemsley (1886) placed the two species together as the sole members of *P.* sect. *Colensoa* (Hook. f.) Baill.

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Wimmer (1943, 1953, 1968) expanded the circumscription of *Pratia* sect. *Colensoa* to include 11 additional species from southeastern Asia and the Neotropics. All were large baccate plants like the first two members, but bore solitary axillary flowers or terminal racemes instead of lateral racemes.

Moeliono (1960) transferred the Malesian species of *Pratia* (including *P. borneensis*) to *Lobelia*, arguing that fruit type was an inadequate basis upon which to distinguish genera among Campanulaceae. However, he did not concern himself with infrageneric classification and the precise relationships of the species within its new home were unstated. Murata (1995) resolved this uncertainty by transferring the sectional epithet from *Pratia* to *Lobelia*, creating *L.* sect. *Colensoa* (Hook. f.) J. Murata. He also expanded the circumscription of the section by adding a dozen species with capsular fruit from Brazil, tropical Africa, and tropical Asia to the baccate species included by Wimmer.

In the recent revision of *Lobelia* (Lammers 2010a), all of the species added to *L.* sect. *Colensoa* by Wimmer and Murata were removed and reassigned to *L.* sect. *Rhynchopetalum* (Fresen.) Benth., *L.* sect. *Speirema* (Hook. f.) Lammers, and *L.* sect. *Tylomium* (C. Presl) Benth. Furthermore, *L. borneensis* was judged to not be closely related to *L. physaloides* A. Cunn., and was likewise removed from *L.* sect. *Colensoa;* as it could not be accommodated in any other section (see below for details), it was segregated as monotypic *L.* sect. *Plagiobotrys.*

Although the type of *Lobelia borneensis* was collected in Sarawak, the majority of specimens come from farther east and north, in Sabah, particularly from the vicinity of Mt. Kinabalu. For many years, the species was considered endemic to Borneo. It was not until well into the Twentieth Century that plants identified as this species were discovered on the Indonesian islands of Sulawesi (Lam 1945), and Flores in the Lesser Sunda Islands (van Steenis 1967).

The only other name referable to *Lobelia* sect. *Plagiobotrys* is *Pratia borneensis* var. *grandiflora.* Kew botanist Otto Stapf based this on a specimen which George Darby Haviland collected on Mt. Kinabalu in March–April 1892 (Stapf 1894; van Steenis-Kruseman 1950; Beaman et al. 2001). Though recognized by Gibbs (1914), it was relegated to synonymy under the species by all subsequent authors (Wimmer 1953; Moeliono 1960; Beaman et al. 2001; Lammers 2007a).

MATERIALS AND METHODS

Morphological data were obtained from about 75 specimens in a dozen herbaria (see Acknowledgments) and analyzed via traditional taxonomic methodology (Leenhouts 1968; Qualls 1986; Vogel 1987; Maxted 1992; Watson 1997; Winston 1999). As I have done with other insular taxa (e.g., Lammers 2007c, 2009), I sought correlations between morphological variation and geographic distribution. Populations of *Lobelia borneensis* are known from just four discrete areas on three islands: (1) the Malaysian state of Sarawak on the island of Borneo at 425–1200 m, (2) the Malaysian state of Sabah on the same island at 975–3500 m; (3) the Indonesian island of Sulawesi at 900–1800 m, and (4) the Indonesian island of Flores in the Lesser Sunda Islands at 1600–1800 m. As in the prior studies, the initial hypothesis was that each area would harbor a single taxon unique to that locale, or at least to that island.

Therefore, when analyzing the data, I asked two questions. First, were all specimens from a given area relatively homogeneous, with most characters evincing a continuous pattern of variation? If so, the hypothesis would be supported; if instead, several characters consistently showed correlated gaps in their patterns of variation within an area, the hypothesis would be refuted. Second, were the plants with a given correlated suite of morphological features restricted to a single area or island? If so, the hypothesis would be supported; if not, the hypothesis would be refuted. Once taxa had been discerned in this fashion, they were compared to the nomenclatural type specimens to determine the correct name under the *International Code of Botanical Nomenclature* (McNeill et al. 2006). Decisions on rank for the taxa were made in light of the definitions of species and subspecies I have employed previously (e.g., Lammers 1991, 2005, 2007a).

RESULTS AND DISCUSSION

Relationships to other species.—As noted above, all previous authors have allied *Lobelia borneensis* to L *physaloides*, the type of *L.* sect. *Colensoa*. These are the only two species of *Lobelia* with lateral racemes, and they further share a moderately robust habit, large serrate petiolate leaves, corolla lobes several times longer than the tube, and baccate fruit. Nevertheless, I find it difficult to accept a close relationship between them.

The value of seed-coat structure in understanding relationships among Lobelioideae has been amply demonstrated (McVaugh 1936, 1940a, 1940b; Murata 1992, 1995; Buss et al. 2001; Lammers 2010). Variation in testal structure correlates well with variation patterns of other morphological features, as well as with phylogenies based on molecular data (Knox et al. 2006, 2008a, 2008b; Antonelli 2008; Givnish et al. 2009). It is largely testal structure that fails to support a close relationship between *Lobelia borneensis* and *L. physaloides*.

In *Lobelia physaloides*, the testa is striate, conforming to Murata Type D. This is by far the most common pattern in the genus, characterizing more than half its species. Its distribution in the more comprehensive molecular phylogenies (Knox et al. 2006; Antonelli 2008) supports Murata's (1992, 1995) hypothesis that it is the ancestral condition within the subfamily, from which each of the other types evolved independently. In contrast, the testa of *L. borneensis* is reticulate, conforming to Murata Type B. This pattern is far less common, occurring elsewhere only in the 43 species of amphi-Pacific *L.* sect. *Hypsela* (C. Presl) Lammers and in the sole species of *L.* sect. *Jasionopsis* Lammers, endemic to the West Cape region of South Africa. On this basis alone, one would hypothesize that *L. borneensis* and *L. physaloides* are not each other's closest relative.

In addition to seed-coat structure, the two species differ in other morphological features (Lammers 2010). In *Lobelia borneensis*, the stem is herbaceous to suffruticose, scrambling or straggling, and up to 3 m long; that of *L. physaloides* is suffruticose at base and fleshy above, erect to ascending, and no more than 1 m tall. Though both bear lateral racemes, those of *L. borneensis* are elongate, bearing as many as 35 flowers over the course of their development, while those of *L. physaloides* are subcorymbose, with rarely as many as 20 flowers. The pedicels in the former are bibracteolate below the middle, while those of the latter have several bracteoles along their length. The corolla of *L. borneensis* is 10–28 mm long with dorsal lobes only ⅔–¾ as long as the ventral and laterally reflexed; that of *L. physaloides* is 30–45 mm long with the dorsal lobes equaling the ventral and erect. The tips of the anthers in *L. borneensis* are bearded with tufts of flattened hairs, while those of *L. physaloides* are nude or nearly so. Finally, the seeds of the former are cuboidal or quadrate and thus quite angular, while those of the latter are ovoid and terete. These numerous differences fail to support a close relationship between *L. borneensis* and *L. physaloides*, and support removal of the former from *L.* sect. *Colensoa*.

As noted above, some of the other baccate Asian species formerly assigned to *Pratia* sect. *Colensoa* have been removed to *Lobelia* sect. *Speirema* (Lammers 2010a, 2010b). These plants do resemble *L.* sect. *Plagiobotrys* in habit and in size and general structure of the flowers, and in an earlier draft of the revised classification, it was planned to assign *L. borneensis* there. However, these species differ in typically bearing solitary axillary flowers on ebracteolate pedicels, in having tufts of filiform hairs on the apex of the two ventral anthers, and in the striate-reticulate (Murata Type C) seed testa. In light of these differences, it seems best not to assign *L. borneensis* to *L.* sect. *Speirema*.

In light of their similarity in testal structure and fruit type, one might suggest that *L. borneensis* is referable to *L.* sect. *Hypsela*. These plants do resemble *L. borneensis* in their blue, purple, magenta, pink, or white corollas with the tube straight or nearly so and shorter than the lobes; many members have petiolate leaves, bibracteolate pedicels, and baccate fruit. However, these plants are far smaller, less than 0.4 m tall, often with stems prostrate or decumbent. Flowers are solitary in the axils of the upper leaves (rarely aggregated into a terminal raceme) and much smaller, with the corolla just 2–15 mm long. The corolla lobes are monomorphic or rarely somewhat dimorphic (vs. dimorphic) and the ventral anthers typically bear just a single long bristle each at apex. Though the seeds of both are reticulate, those in *L.* sect. *Hypsela* are ovoid to oblong and terete or rarely slightly compressed. For these reasons, *L. borneensis* was not assigned to *L.* sect. *Hypsela*, but instead segregated as a monotypic section.

Molecular data (Knox et al. 2006, 2008a; Antonelli 2008) indicate that *Lobelia physaloides* is derived from the endemic Australian taxon *L.* sect. *Holopogon* Benth.; like *L.* sect. *Hypsela*, this section consists of small often decumbent plants, rarely more than 0.4 m tall. One might hypothesize that in a parallel fashion, the larger *L. borneensis* evolved from smaller species referable to *L.* sect. *Hypsela*. Though *L. borneensis* has been sequenced (Givnish et al. 2009), it has yet to be included in the same cladistic analysis with *L. physaloides* or exemplars of *L.* sect. *Hypsela*. Doing so would test the hypothesis presented here.

Species and subspecies.—Careful analysis of the data supported the initial hypothesis: it is possible to determine consistently on the basis of morphology alone whether a specimen identified as *Lobelia borneensis* came from Sarawak, Sabah, Sulawesi, or Flores. Furthermore, in one of these areas (Sabah), two sets of populations can be distinguished on this basis, one occurring between 975–2900 m elevation, the other at 3000–3500 m. As a result of this finding, the originally monotypic *L.* sect. *Plagiobotrys* is here divided into five taxa: three allopatric on Sulwesi, Flores, and Sarawak, the other two parapatric in Sabah.

Most of the differences that serve to distinguish the five taxa involve floral characters, particularly the size, color, and posture of the corolla and staminal column. Such differences often are correlated with pollinator differences and thus may reflect mechanisms of reproductive isolation (Young 1982; Lammers & Freeman 1986; Lammers 1991, 2000, 2009; Thompson & Lammers 1997). As such, they are particularly useful in the taxonomy of the Lobelioideae.

The high-elevation plants on Sabah are the most distinctive of the five taxa, with flowers that are far more darkly pigmented and markedly larger: the ranges of values recorded for quantitative aspects of the hypanthium, corolla, and staminal column (see key below) show in almost all cases a definite gap between this taxon and the remainder. Such differences suggest to me that there is little or no gene flow between the two, despite their parapatry, i.e., they are reproductively isolated. As such, each merits specific rank. Although the four remaining taxa can be distinguished morphologically, the differences are less pronounced, with the ranges of quantitative floral features showing various degrees of overlap. This suggests to me that they are isolated primarily by geography and thus best treated as conspecific subspecies (cf. Lammers 1991, 2004, 2005, 2007c). As a result, *L.* sect. *Plagiobotrys* as recognized here comprises two species, one of which is divided into four allopatric subspecies.

As noted above, only two validly published names are referable to taxa in this section. The type of *Pratia borneensis* is a representative of the Sarawak taxon; as such, the more widespread species takes the name *Lobelia borneensis*, and its Sarawak subspecies is denoted by an autonym. The type of *P. borneensis* var. *grandiflora* represents the low-elevation Sabah taxon; the new combination *L. borneensis* subsp. *grandiflora* is here created for it. The species endemic to higher elevations in Sabah is here christened *L. origenes*, while appropriate names are likewise bestowed on the Sulawesi and Flores subspecies of *L. borneensis*.

TAXONOMY

Lobelia sect. **Plagiobotrys** Lammers, sect. nov. Type: *Lobelia borneensis* (Hemsl.) Moeliono.

Sectio a ceteris *Lobeliae* racemis elongatis pedunculatis lateralibus, trichomatibus applanatis insidens apicibus omnium quinque antherarum, fructibus baccatis, et seminibus cubiformibus vel quadratis cum testa reticulata (Typo B Muratae) distinguenda.

Plants perennial (hemicryptophytes or chamaephytes), 0.7–3 m tall, terrestrial. Stems herbaceous to suffruticose, 2–5 mm diam., branched, straggling or scrambling, moderately leafy, glabrous or sparsely short-pubescent toward apex; latex acrid, viscous, white. Leaves alternate, simple, exstipulate, dorsiventral, pinnately veined (dillenid), petiolate; lamina broadly to narrowly elliptic, narrowly oblong, lanceolate, or ovate, chartaceous to subcoriaceous, glabrous adaxially, glabrous abaxially or short-pubescent on the veins; margin callose-serrate, callose-serrulate, or callose-denticulate, flat; apex acuminate to caudate; base cuneate, obtuse, or rounded; petiole much shorter than the blade. Flowers tetracyclic, perfect and proterandrous, zygomorphic, epigynous, pedicellate and resupinate, 5–35 in a terminal pedunculate bracteate raceme that appears lateral due to overtopping by a branch; axis elongate, short-pubescent; bracts linear, glabrous or short-pubescent; pedicels ascending, spreading, or deflexed, ⅖–3 times as long as its bract, bibracteolate below middle, densely short-pubescent; bracteoles linear, inconspicuous. Calyx synsepalous, tube adnate to the ovary, forming an ellipsoid, broadly ellipsoid, campanulate, depressed ovate, or oblate hypanthium ⅙–⅓ as long as corolla, glabrous or short-pubescent, the base acute, obtuse, rounded, or truncate; lobes 5, valvate, tardily deciduous, linear-triangular or narrowly-triangular, equaling to 4 times as long as the hypanthium, spreading or erect, glabrous or sparsely short-pubescent, the margin entire, the apex acuminate. Corolla sympetalous, zygomorphic, bilabiate, cream-white suffused or marked with pink, blue, or purple, or red-purple or purple, short-pubescent inside and/or out; tube straight, cylindric, about as long as broad, dorsally cleft nearly to base; lobes 5, valvate, dimorphic; the two dorsal lobes oblong, narrowly oblong, or lanceolate, 1¾–7½ times longer than the tube, reflexed laterally, the apex acute or acuminate; the three ventral lobes forming a trifid lip longer than the dorsal lobes and cleft for ⅓–⅞ its length, the segments narrowly oblong, narrowly elliptic, or lanceolate, acuminate at apex. Stamens 5, antisepalous, connate for most of their length; filament tube exserted at least slightly from dorsal slit of corolla, pubescent; dorsal anthers ⅓–⅞ as long as the filament tube and slightly longer than the ventral, overhanging the orifice of the tube and partly occluding it, all five bearded at apex with tufts of flattened white hairs 0.3–0.6 mm long, their surfaces glabrous or sparsely short-pubescent. Gynoecium syncarpous, bilocular; ovary inferior, adnate to the hypanthium for at least ⅔ its length; placentae axile, large; ovules numerous, small, anatropous, unitegmic, tenuinucellate; style solitary, slender, terete, with a ring of stiff white hairs below the apex; stigma bilobed, the lobes appressed and non-receptive as the style grows through the anther tube, pushing out pollen, after which the stigmas spread and become receptive. Fruit a purple globose or oblate berry crowned by the calyx lobes; seeds tan, brown, or golden brown, cuboidal, broadly ellipsoid, broadly oblong, angular or slightly compressed, relatively small; testa reticulate (Murata Type B). Chromosome number unknown (Lammers 1993).

Etymology.—From the Greek *πλαγιος*, "placed sideways," and *βοτρυς* "a bunch of grapes," in allusion to the pedunculate lateral racemes of small purple berries.

KEY TO THE SPECIES AND SUBSPECIES

1. Hypanthium 6–7 mm long; corolla 25–29 mm long, red-purple, the dorsal lobes 15–20 mm long; filament tube 12–13 mm long; anther tube 1.8–2.2 mm diam, 1/3–2/5 as long as filament tube (Sabah) ________ **2. L. origenes**

1. Hypanthium 2.5–5 mm long; corolla 10–22 mm long, white often tinged or marked with pink or purple, the dorsal lobes 6–15 mm long; filament tube 4–7 mm long; anther tube 1.2–1.8 mm diam, 3/5–7/8 as long as filament tube ________ **1. L. borneensis**

  2. Corolla 14–22 mm long, the dorsal lobes 7–15 mm, the ventral lip 12–21 mm long; filament tube 5–7 mm long; dorsal anthers 3.5–5 mm long (Sabah) ________ **1d. L. borneensis** subsp. **grandiflora**

  2. Corolla 10–17 mm long, the dorsal lobes 4–7 mm, the ventral lip 6–11 mm long; filament tube 4–5 mm long; dorsal anthers 2.5–3.5 mm long.

    3. Hypanthium ellipsoid, 2–2.5 mm diam, the base obtuse; calyx lobes erect (Sarawak) ________ **1c. L. borneensis** subsp. **borneensis**

    3. Hypanthium oblate or depressed ovoid, 2.5–5 mm diam, the base truncate; calyx lobes spreading.

      4. Abaxial veins of lamina densely pubescent; bracts 3–8 mm long, 1/3–7/8 as long as its pedicel; calyx lobes 2–4 times longer than hypanthium; corolla 10–13 mm long, the tube 1.8–3 mm diam, the dorsal lobes 1.7–2 mm wide, 2¼–3½ times longer than tube (Sulawesi) ________ **1a. L. borneensis** subsp. **celebensis**

      4. Abaxial veins of lamina sparsely pubescent; bracts 8–23 mm long, equaling to 2½ times longer than its pedicel; calyx lobes 1½–21/3 times longer than hypanthium; corolla 12–17 mm long, the tube 3–3.5 mm diam, the dorsal lobes 1.3–1.5 mm wide, 1¾–2 times longer than tube (Flores) ________ **1b. L. borneensis** subsp. **insulae-florum**

1. Lobelia borneensis (Hemsl.) Moeliono in Steenis, Fl. Males. (ser. 1) 6:133. 1960. *Pratia borneensis* Hemsl., Hooker's Icon. Pl. 16: pl.1532. 1886. Type: MALAYSIA. Sarawak: 1500 ft, Aug 1884, *Hullet 256* (holotype: K!).

Plants 0.7–3 m tall; stems glabrous or sparsely short-pubescent toward apex. Lamina broadly to narrowly elliptic, narrowly oblong, or ovate, 5–16.5 × 1.3–7 cm, chartaceous to subcoriaceous, glabrous adaxially, glabrous abaxially or short-pubescent on the veins; margin callose-serrate, callose-serrulate, or callose-denticulate; apex acuminate to caudate; base cuneate or obtuse; petiole 7–25 mm long. Raceme 5–35-flowered; axis 2–24 cm long; bracts 3–23 × 0.3–1.1 mm, glabrous or short-pubescent; pedicels ascending, spreading, or deflexed, 5–15 mm long, ⅖ as long to 3 times as long as its bract; bracteoles 0.5–2 mm long. Hypanthium ellipsoid, broadly ellipsoid, campanulate, depressed ovate, or oblate, 2–5 × 2–5 mm, ⅙–⅓ as long as corolla, glabrous or short-pubescent; base acute, obtuse, rounded, or truncate. Calyx lobes linear-triangular or narrowly-triangular, 4–12 × 0.5–1.8 mm, equaling to 4 times as long as the hypanthium, spreading or erect, glabrous or sparsely short-pubescent. Corolla cream-white suffused or marked with pink, blue, or purple, 10–22 mm long, short-pubescent inside and/or out; tube 2–4 × 1.5–3.5 mm; dorsal lobes oblong, narrowly oblong, or lanceolate, 4–15 × 1.3–3.5 mm, 1¾–7½ times longer than the tube, the apex acute or acuminate; ventral lip 6–21 mm long, cleft for ⅓–⅞ its length, the segments narrowly oblong or lanceolate, 1.5–4 mm wide. Filament tube 4–7 mm long; anther tube 1.2–1.8 mm diam., its surface sparsely short-pubescent toward apex dorsally; dorsal anthers 2.5–5 mm long, ½–⅞ as long as the filament tube; ventral anthers 2–4 mm long. Berry globose or oblate, 4–13 × 6–14 mm; seeds brown or golden brown, cuboidal or broadly oblong, angular or slightly compressed, 0.7–0.9 × 0.5–0.8 mm (Murata Type B).

Distribution.—Represented by four allopatric subspecies, on Flores, Sulawesi, and Borneo.

1a. Lobelia borneensis subsp. **celebensis** Lammers, subsp. nov. (**Fig. 1A**). TYPE: INDONESIA. SULAWESI: Todjamboe, gebüsch im Regenwald, 900 m, 28 Jun 1929, *Dr. G. Kjellberg 1818* (HOLOTYPE: S!).

Plantae Celebis a plantis *Lobeliae borneensis* insularum ceterarum nervis abaxialibus foliarum dense pubescentibus, bracteis floralibus 3–8(–12) mm longis cum pedicellis ascendentibus, hypanthio oblata basi truncato cum calycis lobis patentibus, et corollae lobis 2.2–3.5plo corollae tubo longioribus distinguenda.

Plants 2–3 m tall, glabrous or sparsely short-pubescent toward apex. Lamina elliptic or narrowly oblong, 7–15 × 2.3–5.2 cm, densely short-pubescent on abaxial veins; margin callose-serrulate; apex acuminate, base cuneate or obtuse; petiole 10–22 mm long. Raceme 10–28-flowered; axis 5–24 cm long, moderately to densely short-pubescent; bracts 3–8 × 0.5 mm, sparsely short-pubescent; pedicels ascending, 6–12 mm long, equaling to 2½ times as long as its bract. Hypanthium oblate, 2–2.5 × 2–4 mm, ⅕–¼ as long as corolla, sparsely short-pubescent; base truncate. Calyx lobes linear-triangular or narrowly triangular, 4–12 × 0.5–1.7 mm, 2–4 times as long as the hypanthium, spreading, glabrous. Corolla cream-white suffused with blue or purple, 10–13 mm long, sparsely to densely short-pubescent externally; dorsal lobes oblong, 4–7 × 1.8–2 mm, 2¼–3½ times longer than the tube; ventral lip 6–11 mm long, cleft for ½–⅘ its length, the segments lanceolate, 1.5–2 mm wide. Filament tube 4–5 mm long; anther tube 1.5–1.6 mm diam.; dorsal anthers 2.5–3.5 mm long, ½–⅞ as long as the filament tube; ventral anthers 2–2.5 mm long. Seeds cuboidal, angular, 0.7–0.8 × 0.5–0.6 mm.

Distribution, habitat, and phenology.—Endemic to the island of Sulawesi in Indonesia. Wet montane forests, 900–1800 m. Flowering and fruiting January through August.

Etymology.—From *Celebes*, the name bestowed on the island by Portugese navigators, and the Latin geographical suffix *-ensis*.

Discussion.—This subspecies is distinctive by virtue of the dense pubescence on the abaxial leaf veins; in the other subspecies, the pubescence is much sparser or even absent and the hairs sometimes far smaller. Its oblate truncate hypanthium and spreading calyx lobes are shared with the next subspecies, and distinguish the extra-Bornean taxa collectively.

Representative specimens: **INDONESIA. SULAWESI:** Masamba, Limboeng-Maboesa, *Eyma 1165* (K, L); Masamba, between Tetahi and Toeke-aho-pass, *Eyma 1552* (L); Poso, Maraowa, N side, *Eyma 1552bis* (L); onder afd. Makale, Rantepao, Toradjalanden, *C. Monod de Froideville 192* (L); G. Batoe, *Rachmat 435* (L); G. Katonghoān, *Rachmat 1007* (L).

1b. Lobelia borneensis subsp. **insulae-florum** Lammers, subsp. nov. (**Fig. 1B**). TYPE: INDONESIA. LESSER SUND ISLANDS: Flores, Ruteng, Lusang Pass, steep rocky slopes, hanging from steep cliff, 1600 m, 16 Jun 1975, *J.F. Veldkamp 7007* (HOLOTY [on two sheets]: L! ISOTYPE: MO!).

Plantae Insulae Florum a plantis *Lobeliae borneensis* insularum ceterarum nervis abaxialibus foliarum spare pubescentibus, bracteis flo-

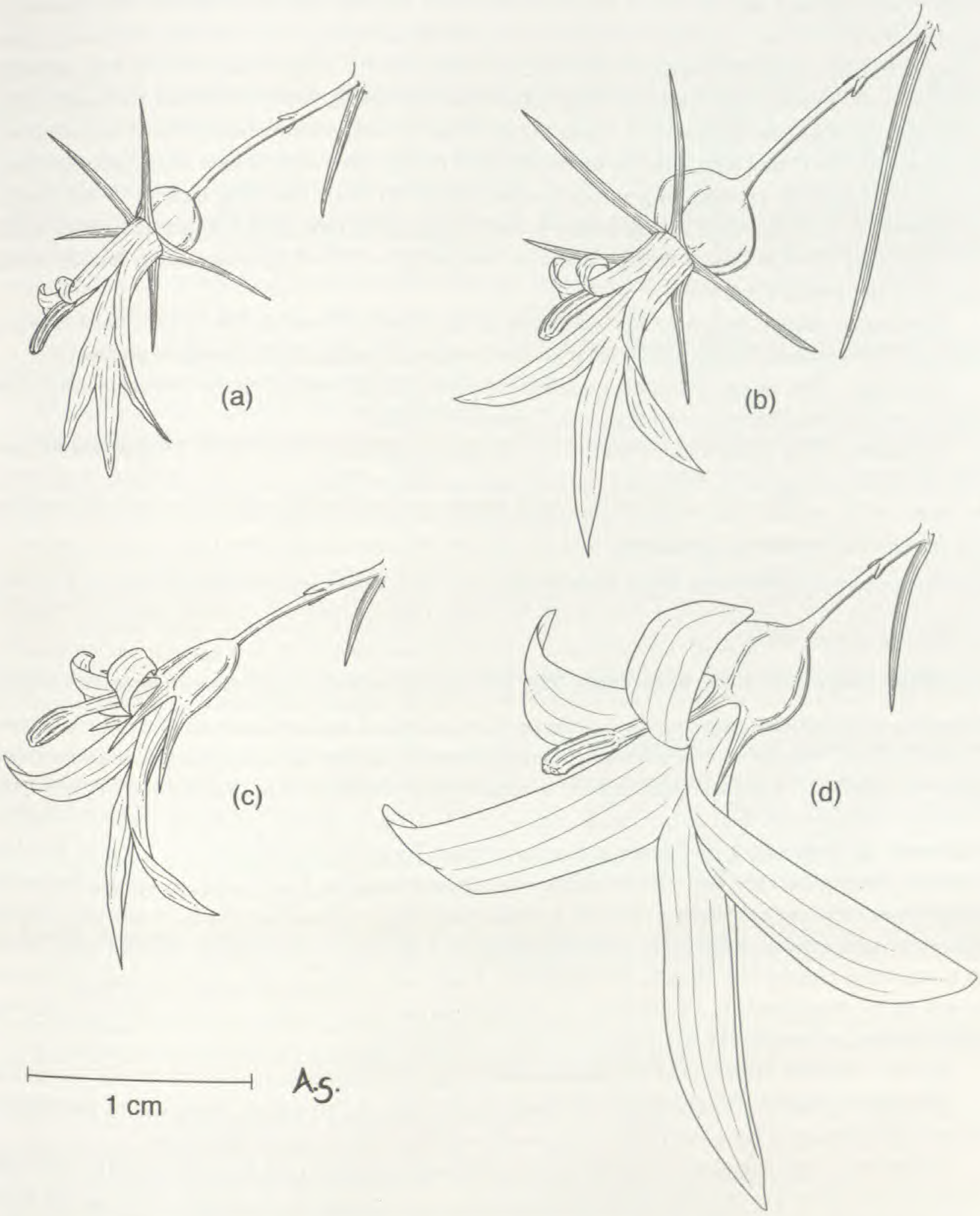

Fig. 1. **Flowers of the subspecies of *Lobelia borneensis* (based on the respective holotypes). A. *Lobelia borneensis* subsp. *celebensis*. B. *Lobelia borneensis* subsp. *insulae-florum*. C. *Lobelia borneensis* subsp. *borneensis*. D. *Lobelia borneensis* subsp. *grandiflora*.**

ralibus 8–23 mm longis cum pedicellis ascendentibus, hypanthio oblata vel depresso-ovata basi truncato cum calycis lobis patentibus, et corollae lobis sesqui- vel duplo corollae tubo longioribus distinguenda.

Plants 1–3 m tall; stems glabrous. Lamina elliptic, 6–16 × 1.9–5.6 cm, sparsely short-pubescent on abaxial veins; margin callose-serrate, callose-serrulate, or callose-denticulate; apex acuminate; base cuneate or obtuse;

petiole 17–25 mm long. Raceme 28–35-flowered; axis 12–15 cm long, sparsely to densely short-pubescent; bracts 8–23 × 0.6–1.1 mm, sparsely short-pubescent; pedicels ascending, 7–13 mm long, ⅖ as long to about as long as its bract. Hypanthium depressed ovate or oblate, 2.5–4.5 × 2.5–5 mm, ⅖–⅓ as long as corolla, short-pubescent in lines; base truncate. Calyx lobes linear-triangular, 5–9 × 1–1.2 mm, half again as long to 2½ times as long as the hypanthium, spreading, glabrous. Corolla cream-white suffused or marked with blue or purple, 12–17 mm long, sparsely short-pubescent in lines externally; dorsal lobes narrowly oblong, 6–7 × 1.3–1.5 mm, 1½ –2 times longer than the tube; ventral lip 10–11 mm long, cleft for ⅓–⅞ its length, the segments 1.5–2.5 mm wide. Filament tube 4–5 mm long; anther tube 1.4–1.5 mm diam.; dorsal anthers 3–3.5 mm long, ⅔–¾ as long as the filament tube; ventral anthers 2.5–3 mm long. Seeds broadly oblong, slightly compressed, 0.8 × 0.6 mm.

Distribution, habitat, and phenology.—Endemic to the island of Flores in the Lesser Sunda Islands of Indonesia. Wet montane forests, 1600–1800 m. Flowering and fruiting April through September.

Etymology.—The subspecific epithet is a Latin genitive phrase translating the Portugese name of the island to which the subspecies is endemic, i.e., "island of flowers."

Discussion.—This subspecies is distinctive in the great length of its bracts (up to 23 mm long and more than 2½ times as long as the subtended pedicel) and the relative brevity of its dorsal corolla lobes (twice the length of the corolla tube or less). It resembles *Lobelia borneensis* subsp. *celebensis* in its oblate truncate hypanthium and spreading calyx lobes.

Representative specimens: **INDONESIA. Lesser Sunda Islands:** Flores, Manau near Ruteng, *Kostermans & Wirawan 651* (K, L); Flores, Ruteng, Kl. Soenda, *Father E. Schmutz 482* (L); Flores, Ruteng, Mt. Kasteno, *Father E. Schmutz 3227* (L); Flores, *Father J.A.J. Verheijen 2175* (L), *Father J.A.J. Verheijen 2857* (L).

1c. Lobelia borneensis subsp. **borneensis.** (**Fig. 1C**). Autonym created here by publication of the other three subspecies.

Plants 0.9–1.2 m tall; stems sparsely short pubescent toward apex. Lamina broadly elliptic, elliptic, or ovate, 7.5–16.5 × 3.2–7 cm, glabrous or minutely sparsely pubescent on abaxial veins; margin callose-serrulate; apex short-caudate or acuminate; base cuneate or obtuse; petiole 9–18 mm long. Raceme 7–23-flowered; axis 7.5–19 cm long, densely short-pubescent; bracts 3–7 × 0.3–0.5 mm, sparsely pubescent; pedicels spreading to deflexed, 5–15 mm long, ⅞–3 times as long as its bract. Hypanthium ellipsoid, 3 × 2.3 mm, ¼ as long as corolla, short-pubescent; base obtuse. Calyx lobes linear-triangular, 4 × 0.5 mm, ⅓ again as long as the hypanthium, erect, sparsely short-pubescent. Corolla cream-white suffused with blue, 12 mm long, sparsely short-pubescent within; dorsal lobes narrowly oblong, 6 × 1.5 mm, 3 times longer than the tube; ventral lip 10 mm long, cleft for ⅗ its length, the segments 1.5 mm wide. Filament tube 4–5 mm long; anther tube 1.2 mm diam.; dorsal anthers 2.5 mm long, ⅗–⅔ as long as the filament tube; ventral anthers 2.2 mm long. Seeds cuboidal or broadly oblong, angular, 0.7–0.9 × 0.6–0.7 mm.

Icones.—Hemsley (1886), pl. 1532; Murata (1995), figs. 30–31 [seed].

Distribution, habitat, and phenology.—Endemic to the state of Sarawak in Malaysia, on the island of Borneo. Wet montane forests and riverine forests, 425–1200 m. Flowering in September.

Discussion.—This subspecies is distinctive in its deflexed or spreading pedicels; those of the other three subspecies are ascending. Its ellipsoid hypanthium obtuse at base and the erect calyx lobes are also found in the other Borneo taxon, *Lobelia borneensis* subsp. *grandiflora*. However, it resembles *L. borneensis* subsp. *celebensis* and *L. borneensis* subsp. *insulae-florum* in having flowers much smaller than in that subspecies.

Representative specimens: **MALAYSIA. Sarawak:** Kuching District, Mount Penrissen, N side, *J.H. Beaman et al. 11888* (K); Matang, *Dr G.D. Haviland 577* (K); Bkt. Kumbong, Btg. Balui, Kapit, *Runi et al. 62049* (MO).

1d. Lobelia borneensis subsp. **grandiflora** (Stapf) Lammers, comb. et stat. nov. (**Fig. 1D**). *Pratia borneensis* var. *grandiflora* Stapf, Trans. Linn. Soc. London, Bot. 4: 188 (1894). Type: MALAYSIA. Sabah: Dahombang, seldom flooded part of bed, 3000 ft, *Dr. G.D. Haviland 1309* (holotype: K! isotype: K!).

Plants 0.7–2 m tall; stems glabrous or sometimes sparsely short pubescent toward apex. Lamina broadly to narrowly elliptic, 5–15 × 1.3–5.2 cm, minutely sparsely pubescent on abaxial veins; margin callose-serrulate to callose-serrate; apex caudate or acuminate; base cuneate; petiole 7–20 mm long. Raceme 5–22-flowered; axis 2–15 cm long; bracts 6–11 × 0.5–1 mm, glabrous or sparsely short-pubescent; pedicels ascending, 5–10 mm long, ⅔ as long to a little longer than its bract. Hypanthium broadly ellipsoid or campanulate, 3–5 × 2.5–4 mm, ⅙–¼ as long as corolla, glabrous or sparsely short-pubescent; base acute, obtuse, or rounded. Calyx lobes linear-triangular to narrowly-triangular, 4–8 × 0.7–1.8 mm, equaling to 2¼ times as long as the hypanthium, erect, glabrous. Corolla cream-white suffused or marked with pink or purple, 14–22 mm long, pubescent within; dorsal lobes oblong or lanceolate, 7–15 × 1.5–3.5 mm, 3–7½ times longer than the tube; ventral lip 12–21 mm long, cleft for ½–¾ its length, the segments 1.5–4 mm wide. Filament tube 5–7 mm long; anther tube 1.2–1.8 mm diam.; dorsal anthers 3.5–5 mm long, ⅗–⅘ as long as the filament tube; ventral anthers 2.5–4 mm long. Seeds broadly ellipsoid, slightly compressed, 0.8–0.9 × 0.7–0.8 mm.

Icones.—Wimmer (1943), fig. 30b; Beaman et al. (2001), pl. 12D.

Distribution, habitat and phenology.—Endemic to the state of Sabah in Malaysia. Wet montane forests, 975–2900 m. Apparently flowering and fruiting year-round.

Vernacular names.—Dusun: akar maga pawang.

Discussion.—The flowers of this subspecies are by far the largest in *Lobelia borneensis*, approaching in size those of its sister-species, *L. origenes*. Of the other subspecies, it is most similar to *L. borneensis* subsp. *borneensis* by virtue of its ellipsoid hypanthium obtuse at base and its erect calyx lobes.

Representative specimens: **MALAYSIA. SABAH:** S slope of Mt. Kinabalu, ca 5 mi NW of Kundasan, *L. B. Abbe et al. 9982* (NY); Mt. Kinabalu National Park, Liwagu River drainage, *E. F. Anderson 4318* (MO); Tambunan, Crocker Range, Km 55.4 on Kota Kinabalu – Tambunan Road, *J.H. Beaman et al. 7298* (K, L, MO, MSC, NY); Ranau, Pinosuk Plateau, East Mesilau River, *J.H. Beaman et al. 8548* (CAS, L, MO, MSC, NY); Tambunan, Crocker Range, Km 58.2 on Kota Kinabalu – Tambunan Road, *J.H. Beaman et al. 8898* (L, MSC); Kundasan, vicinity of Forest Rest House, *A. L. Bogle et al. 356* (NY); Mt. Kinabalu, vicinity of Kambaranga, *A. L. Bogle et al. 396* (NY); S slope Mt. Kinabalu, trail from Mesilau Cave to Janet's Halt, *S. Collenette 21639* (K, L); Mt. Kinabalu National Park, road to summit, *T. B. Croat 53125* (MO); Mt. Kinabalu, Tenompok, *J. Clemens & M. S. Clemens 27474* (B, F, L, M, NY); Mt. Kinabalu, Colombon River, *J. Clemens & M. S. Clemens 35055* (L, NY); Upper Kinabalu, Gurulau spur, *J. Clemens & M. S. Clemens 50943* (NY); Mt. Kinabalu, below Kamburango, *F. R. Fosberg 44126* (OSH); Ranau, Tenompok, *M. Kadir A1665* (K, L); Ranau, Kinabalu Nat. Park behind Hqrs., *A. Kanis 50114* (K); Penampang, road from Agr. Exp. Station to south of G. Alab, *S. Kokawa & M. Hotta 1829* (L); Kinabalu National Park, road between HQ and Tenumpok, *S. Kokawa & M. Hotta 3041* (L); Ranau, Tenompok, *W. Meijer 20309* (L); G. Alab, 22 Feb 1969, *H. P. Nooteboom 986* (B, L); Kinabalu, power station, *W. R. Price 153* (K); Mt. Kinabalu, Lumu-lumu, *J. Sinclair et al. 9218* (L, M); Mt. Kinabalu, near radio station, *J. B. Smith 565* (L); Ranau, Kinabalu National Park, Silam-Silam trail, *P. F. Stevens et al. 679* (L); route up to G. Alap, Tambunan, *J. B. Sugau 67* (HAST); Ranau, Mesilau, *M. Ubaldus 131286* (K); Tenompok, *Anin et al. 123409* (K).

2. **Lobelia origenes** Lammers, sp. nov. (**Fig. 2**). TYPE: MALAYSIA. SABAH ["North Borneo"]: Mt. Kinabalu, eastern shoulder, from head of valley at entrance to Shangri-La valley, very damp and shady, forming dense low thicket, above Camp V, ca 11,500 ft, 5 Aug 1961, *Mrs. Collenette 791* (HOLOTYPE: K!).

Plantae ob racemos laterales nunantes et baccas atroviolaceas *Lobeliae borneensi* valde simulantes sed montes superiores incolentes; floribus grandioribus cum hypanthio 6–7 mm longo, corolla atrovinosa 25–29 mm longa, corollae lobis dorsalibus 12–13 mm longis, et antherarum tubo 1.8–2.2 mm diametro longitudine ⅓–⅖ filamentorum tubi aequanti distinguenda.

Plants 1–1.5 m tall; stems glabrous. Lamina ovate, lanceolate, or elliptic, 7–12 × 2.3–4.4 cm, subcoriaceous, glabrous or minutely sparsely pubescent on veins abaxially; margin minutely callose-denticulate; apex acuminate; base rounded, obtuse, or cuneate; petiole 5–17 mm long. Raceme 6–11-flowered; axis 7–11 cm long; bracts 10–18 mm × 0.5–1.4 mm, glabrous, the margin entire; pedicels ascending, 9–14 mm long, equaling to a bit shorter than the subtended bract; bracteoles 1.5–2 mm long. Hypanthium ellipsoid, 6–7 × 4.5–5.5 mm, ¼ as long as corolla, sparsely short-pubescent; base acute or obtuse. Calyx lobes narrowly triangular, 7–10 × 1.3–1.8 mm, equaling to half again as long as the hypanthium, erect, glabrous. Corolla red-purple or purple, 25–28 mm long, sparsely short-pubescent inside and out; tube 3.5–4.5 × 3.5–4 mm; dorsal lobes narrowly oblong, 15–20 × 2–2.5 mm, 3½–5 times longer than the tube, apex acute; ventral lip 21–23 mm long, cleft for ¾–⅞ its length, the segments narrowly elliptic, 3–3.3 mm long. Filament tube 12–13 mm long; anther tube, 1.8–2.2 mm diam., its surface glabrous or sparsely short-pubescent at base; dorsal anthers 5–5.5 mm long, 1/3–2/5 as long as the filament tube; ventral anthers 4–4.5 mm long. Berry globose, 15–16 × 15–16 mm; seeds tan, oblong or broadly ellipsoid, angular or slightly compressed, 1–1.2 × 0.7–0.8 mm.

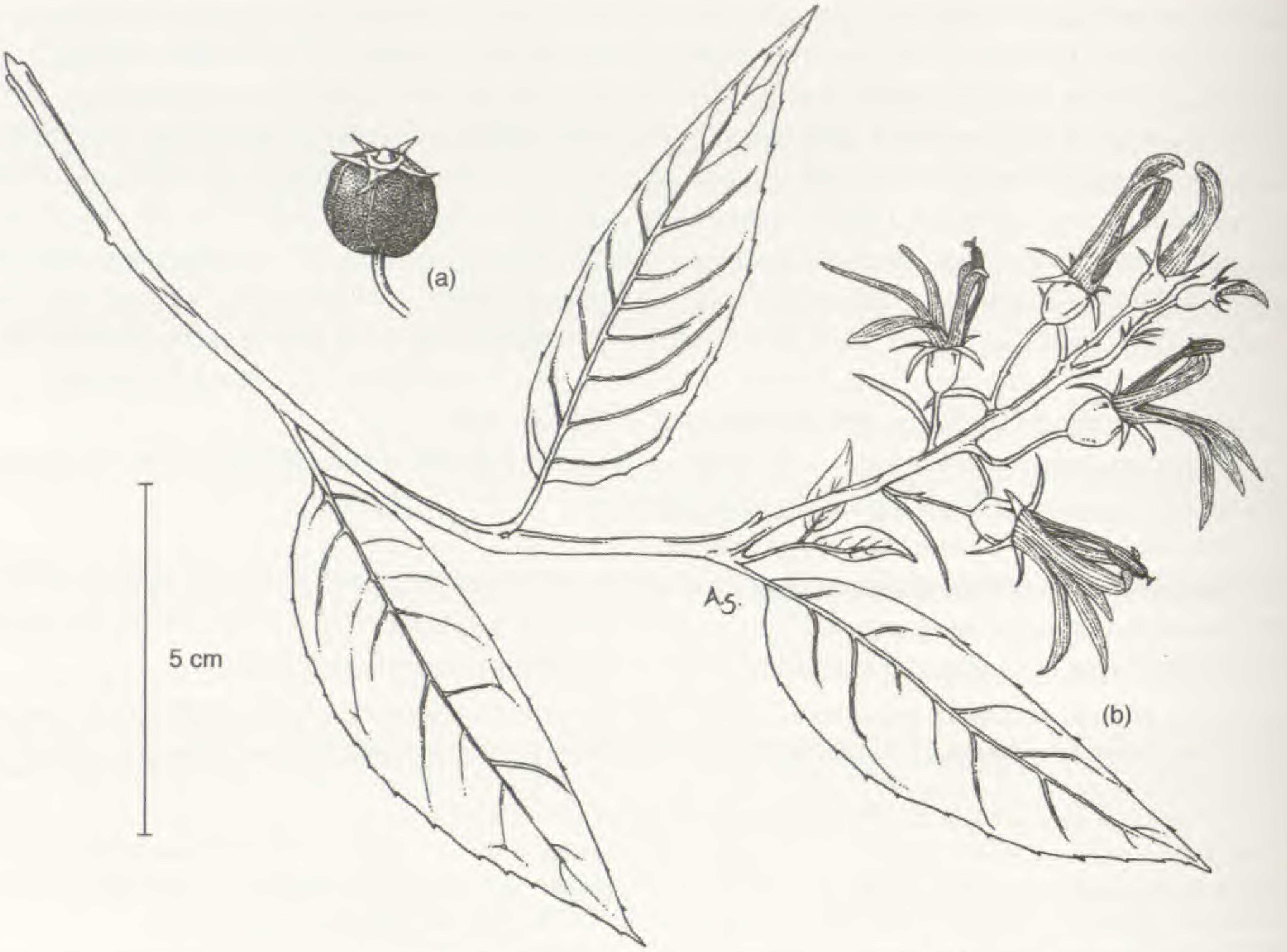

Fig. 2. ***Lobelia origenes*. A. Berry (based on *Chew et al. 880* (K). B. Flowering branch (based on the holotype).**

Distribution, habitat, and phenology.—Endemic to the eastern shoulder of Mt. Kinabalu on northern Borneo, in the Malaysian state of Sabah. Evergreen broadleaf forest, 3000–3500 m; flowering and fruiting July–August.

Etymology.—From the Greek ὀρειγενης, "mountain-born," in reference to its hypothesized origin as a high-elevation derivative of *L. borneensis*.

Discussion.—These specimens were originally identified as *Lobelia borneensis*, and the type was cited under that name by Beaman et al. (2001). That species also occurs on Kinabalu, but only at elevations of 975–2900 m; it would seem to be the progenitor of *L. origenes*. The pronounced gap in corolla size and color and in filament column length, in addition to the elevational separation, suggest that the two are reproductively isolated by pollinator differences.

Representative specimens: **MALAYSIA. Sabah:** Mt. Kinabalu, eastern shoulder, *Chew et al. 880* (K, L).

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REHABILITACIÓN Y LECTOTIPIFICACIÓN DEL GÉNERO *TESSIERA*, SU RELACIÓN CON *DIPHRAGMUS* Y *STAELIA* (RUBIACEAE: SPERMACOCEAE): UNA NUEVA COMBINACIÓN Y UN NUEVO SINÓNIMO

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RESUMEN

Durante la revisión del género americano *Staelia*, se constató que algunas de las especies no se ajustaban a los caracteres que definen al género. Por este motivo se analizaron todas las especies incluidas en *Staelia*, con el fin de establecer las especies pertenecientes a *Staelia* s. str. y reubicar a los restantes taxones en otros géneros de la tribu Spermacoceae. El análisis nomenclatural de *Staelia*, permitió observar la estrecha relación histórica y morfológica con algunos géneros, particularmente con *Tessiera* y *Diphragmus*, que fueron incluidos o segregados de *Staelia* de acuerdo a criterios de otros autores. *Tessiera* fue descrito en base a dos especies, *T. lithospermoides* de México y *T. lanigera* de Brasil, mientras que la descripción de *Diphragmus* se basó en una única especie de México: *D. scaber*. Las especies analizadas en este trabajo son las consideradas endémicas de México. Como resultado de este análisis se comprueba que *Tessiera* y *Diphragmus* son sinónimos. En este trabajo se reconocen los límites de los géneros y especies en estudio, basados en aportes de la morfología polínica, carpológica y seminal. Se concluye que las diferencias encontradas en las especies de México, son suficientes para separarlas de las demás especies sudamericanas de *Staelia*. Por lo tanto, se propone rehabilitar el género *Tessiera* sobre la elección de *T. lithospermoides* DC. como especie tipo. Se redescribe a *Tessiera*, se propone una nueva combinación y se reduce a *Diphragmus scaber* var. *minor* como nuevo sinónimo de *Tessiera lithospermoides*, la cual es ilustrada por primera vez.

Palabras Clave: *Tessiera*, *T. hexasepala*, *T. lithospermoides*, Spermacoceae, Endémico, México

ABSTRACT

During a study of the American genus *Staelia*, we noticed that some species classified in the genus did not fit the characters that define the genus. For this reason all species recognized in *Staelia* were analyzed. Some species remained in *Staelia* s.str. and other taxa were transferred to other genera of the Spermacoceae. The detailed study of *Staelia* was important in understanding how closely related the genus is with *Tessiera* DC. and *Diphragmus* C. Presl. Both of the later genera have been treated as separate genera or part of *Staelia*. *Tessiera* was described on the basis of two species, *T. lithospermoides* DC. from Mexico and *T. lanigera* DC. from Brazil, while *Diphragmus* was based on one species—*D. scaber* C. Presl—from Mexico. In this work, the endemic species of Mexico are analyzed. In order to understand the relationships between species, we examined type specimens of each taxon and believe that *Tessiera* and *Diphragmus* are nomenclatural synonyms. In addition, we examined the pollen grains and several morphological characters of the fruits and seeds. We found that the Mexican species have sufficient differences to separate them from the South American species of *Staelia*. Therefore, we propose to ressurect the genus *Tessiera* and select *T. lithospermoides* DC. as the type species. *Tessiera* is recircumscribed, a new combination is made, and *Diphragmus scaber* var. *minor* is reduced to a synonym of *T. lithospermoides*. The later species is illustrated.

Key Words: *Tessiera*, *T. hexasepala*, *T. lithospermoides*, Spermacoceae, Endemic, Mexico

INTRODUCCIÓN

En el transcurso del estudio de los géneros americanos de la tribu Spermacoceae s. str. (Robbrecht 1988), se analizaron tres taxones con estrecha afinidad histórica y morfológica, a fin de establecer sus correspondientes límites taxonómicos: *Staelia* Cham. & Schltdl., *Tessiera* DC. y *Diphragmus* C. Presl.

Staelia fue descripto por Chamisso & Schlechtendal (1828) basado en una especie que vive en el sur de Brasil: *S. thymoides* Cham. & Schltdl. Los autores definieron al género esencialmente por las características del fruto: "Capsula membranacea, bilocularis, bivalvis, disepimento integro persitente, valvulis linea a dissepimento declivi basi scissis seorsum deciduis." Solo dos años después, Candolle (1830) agrega dos especies

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nuevas de Brasil. El número de especies de *Staelia* se incrementa para ese país cuando Schumann (1888) en las Rubiáceas de *Flora Brasiliensis*, describe cuatro especies nuevas. En esa obra este autor agrupa a las especies brasileñas en tres secciones: sec. *Tessiera* (DC.) K. Schum. (=*Tessiera*), con dos especies; sec. *Staelia* con siete especies y una nueva sección, *Anthospermopsis* K. Schum. con una nueva especie. Esta clasificación se mantuvo hasta que Kirkbride (1997) eleva la sec. *Anthospermopsis* al rango genérico: *Anthospermopsis* (K. Schum.) J.H. Kirkbr.

En el transcurso de la revisión de *Staelia* se comprobó que desde su descripción hasta el presente se lo vinculó con varios géneros afines, los que fueron incluidos o segregados de *Staelia* de acuerdo al criterio de los autores.

Tessiera fue descripto por Candolle (1830) en base a dos especies: *T. lanigera* DC. (Brasil) y *T. lithospermoides* DC. (México). El autor resaltó desde la descripción original su afinidad con *Staelia* por la dehiscencia de los frutos. A este género lo definió por los caracteres de dehiscencia del fruto: "*Capsula bilocularis bivalvis, dissepimento integro ovali deciduo, valvulis concavis calycis dentibus coronatis seorsum deciduis, verticaliter secus dissepimentum sectis.*" Con respecto al tipo de las dos especies, el material de *Tessiera lanigera* de Brasil, consultado en el herbario de Viena (W), tiene datos de localidad y fecha coleccionado por Pohl, sin embargo el de *T. lithospermoides* de México, carece de datos de localidad precisa. El autor mencionó también en el protólogo de la especie que el material original pertenecía al herbario Haenke (actualmente PR). Con respecto a la fecha de colección, se puede estimar entre los años 1791–1792, durante la expedición por América de Haenke en la nave del capitán *Malaspina*. En ese período Haenke visitó y colectó en numerosos estados de México (Nayarit, Guerrero, Oaxaca), razón por la cual se hace difícil precisar la localidad típica de dicha especie (Sternberg 1825; Slavík & Ceska 2006).

Don (1834), en su estudio de géneros de Rubiaceae, reconoció a *Tessiera* y amplió su descripción "Stigma 2-lobed. Capsule 2-celled, 2-valved, with an entire oval deciduous dissepiment; valves concave, crowned by the teeth of the calyx, falling asunder from being cut vertically along the dissepiments." En la misma obra también señaló algunos caracteres para diferenciar las dos especies conocidas hasta ese momento, según este autor *Tessiera lanigera* presenta toda la planta con un indumento lanoso blanquecino mientras que *T. lithospermoides* tiene un indumento gris, aterciopelado, corto y fruto glabro.

Diphragmus C. Presl fue descripto por Presl (1844), basado en *D. scaber* C. Presl. En la descripción el autor indicó que el material estudiado fue colectado en México probablemente por Haenke. Se considera la posible validez del coleccionista, porque la colección de Haenke fue la base de los estudios de Presl, publicados en gran parte en *Reliquiae Haenkeanae* (Presl 1825–1830; Skočdopolová & Štěpánek 2002). Presl trabajó durante mucho tiempo con la colección de Haenke en el herbario PR, donde también se encuentra depositado el material tipo que fue consultado por Candolle (1830). El material tipo de *Diphragmus scaber* no fue localizado en los herbarios de Praga, PR ni en PRC, lo que hace suponer que Presl ignoró la existencia de *Tessiera* de Candolle y usó para su descripción el tipo de *Tessiera lithospermoides*. Después de analizar numerosas colecciones identificadas con este nombre, se determinó que *Diphragmus scaber* y *Tessiera lithospermoides* son conspecíficos.

Autores como Endlicher (1838), Dietrich (1839) y Steudel (1841) aceptaron como válidos a los géneros hasta aquí tratados, *Staelia* y *Tessiera*, reconocieron las especies descriptas hasta ese momento, sin embargo desconocían a *Diphragmus*.

Con respecto a *Diphragmus* y *Tessiera*, fueron mantenidos hasta que Hooker (1873) los incluyó como sinónimos de *Spermacoce* L. Él señaló que las características del fruto de *Diphragmus* no son suficientes para mantenerlo como género aparte y que el indumento lanoso de *Tessiera* se puede observar en otras especies de *Spermacoce*. Sin embargo no mencionó la consulta de los ejemplares tipo de cada taxón para soportar los cambios propuestos. Siete años después, Baillon (1880) propuso una nueva delimitación para la tribu Spermacoceae, donde respetó la propuesta de Hooker, sobre la sinonimia de *Spermacoce* e incluyó como sinónimo también a *Staelia*. El amplio concepto de Baillon con respecto a *Spermacoce* también incluye como sinónimos *Mitracarpus* Zucc. ex Schult. & Schult. f., *Hypodematium* A. Rich., *Diodia* L., *Dasycephala* DC. y

Octodon Thonn. A pesar de la relación señalada por Hooker y Baillon, existen marcadas diferencias en los frutos de *Tessiera* y *Diphragmus* con los de *Spermacoce*.

Schumann (1888), propuso una nueva delimitación para la tribu Spermacoceae, concepto que él mismo defendió en sucesivos trabajos (Schumann 1888, 1891, Delprete et al. 2005). En esta postura él contradijo y discutió la propuesta de Hooker y la de Baillon, que incluyeron numerosos taxones como sinónimos de *Spermacoce*. Schumann, no mencionó a *Diphragmus*, revalidó a *Staelia* e incluyó *Tessiera* como una sección de *Staelia*.

Con respecto a *Tessiera*, Kuntze (1902) siguió el criterio de Schumann (1888), lo reconoció en la circunscripción de *Staelia*, mientras que para *Diphragmus*, siguió la propuesta de Hooker y lo mantuvo bajo la sinonimia de *Spermacoce*, sin realizar la combinación correspondiente. Standley (1931), fue el primero en relacionar y transferir a *Diphragmus* como sinónimo de *Staelia*, realizó la nueva combinación con la especie mexicana, *Staelia scabra* (C. Presl) Stand. (=*Diphragmus scaber*). Él señaló que en la mayoría de las especies del género *Staelia*, la porción central del fruto es persistente y que la dehiscencia es transversal-oblicua cerca de la base. Además él comentó, que la planta mexicana presenta diferencias en la dehiscencia, que en *Diphragmus* "no es transversal-oblicua como en *Staelia*." A pesar de esto Standley realizó la nueva combinación, porque observó que el tabique intercarpelar persiste visible entre las brácteas, como ocurre en *Staelia*. El criterio de mantener a *Diphragmus scaber* bajo el nombre de *Staelia scabra* fue seguido en algunos trabajos de especies mexicanas (Domínguez-Licona & Ochoterena 2006; Lorence 1990, 1999; Lott 1985; Nava et al.1998; Villaseñor 2004).

Si bien histórica y morfológicamente *Tessiera* y *Diphragmus* estuvieron más relacionados con *Staelia*, autores contemporáneos como Delprete & Cortés-B (2006) o Dessein (2003) mantuvieron a estos géneros bajo la sinonimia de *Spermacoce* y no de *Staelia*, coincidiendo con la propuesta original de Hooker (1873).

Durante el estudio de las Rubiáceas de México, Borhidi & Lozada (2006) realizaron un análisis comparativo entre la especie de *Staelia* de México y las de Brasil y encontraron diferencias en la morfología del fruto, como lo había observado Standley (1931). Dichos autores sostuvieron que las características de flor, fruto y semilla son suficientes para revalidar a *Diphragmus* y confirmar su endemismo para México, sin embargo no mencionan la consulta del tipo de *D. scaber*. En ese trabajo también describieron una nueva especie *D. hexasepalus* Borhidi & Lozada-Pérez y en el mismo año, Borhidi (2006) describió una nueva variedad de *D. scaber* var. *minor* Borhidi & Lozada-Pérez.

Con respecto a *Tessiera* se estudiaron los ejemplares tipo de las dos especies de Candolle, *T. lanigera* depositado en W y *T. lithospermoides* de PR y GOET. A partir de este análisis coincidimos con los autores que habían observado diferencias en el indumento entre la especie brasileña y la mexicana, y se agregaron además diferencias en caracteres florales, carpológicos, seminales y polínicos. Como resultado de estas observaciones concluimos que ambas especies pertenecen a distintos géneros.

En este trabajo coincidimos con la propuesta de Borhidi & Lozada de agrupar a las especies mexicanas en un género separado de *Staelia*. Por todo lo expuesto se rehabilita a *Tessiera* y se lectotipifica el género, basado en el Art. 9.2 del ICBN. Se considera a *Diphragmus* como sinónimo nomenclatural de *Tessiera*, debido a que fue descripto a partir del tipo de *T. lithospermoides* depositado en PR, por lo tanto *Diphragmus* es un nombre ilegítimo (ICBN Art. 14.4). Se redescribe a *Tessiera* y a las dos especies que lo integran. Se realiza una nueva combinación y se reduce a *Diphragmus scaber* var. *minor* a la sinonimia de *T. lithospermoides*. Se presentan microfotografías de polen y semilla y se ilustra *T. lithospermoides*.

RELACIÓN INTERGENÉRICA *TESSIERA-STAELIA*

Si se considera el vínculo previo del género *Tessiera* con *Staelia*, se pueden establecer las siguientes diferencias:

Staelia es un género sudamericano con 17 especies (Salas & Cabral 2010). Presenta el fruto con una dehiscencia septífraga, longitudinal y oblicua separado en tres piezas, dos apicales o valvas, caducas y una basal persistente. La dehiscencia de su fruto comienza longitudinalmente desde el ápice hasta la mitad y desde allí sigue una línea oblicua hacia abajo. En el fruto de *Staelia* la pieza basal está formada por el tabique intercarpelar, el pedicelo y la porción inferior de las paredes de los carpelos, razón por la cual presenta un marcado corte oblicuo. Sin embargo en las especies mexicanas de *Tessiera* la pieza persistente está formada únicamente por los tabiques intercarpelares y el pedicelo, y en la base presenta un pequeño corte horizontal (Fig. 1 F–I). A diferencia de *Tessiera*, la semilla de *Staelia* tiene la cara ventral con dos surcos angostos longitudinales a ambos lados del estrofíolo, la testa presenta células regularmente retículo-foveadas. Con respecto a las flores, *Staelia* tiene cáliz 2-lobado, lóbulos iguales, corola generalmente blanca, en el interior con anillo continuo de pelos moniliformes y estigma bífido papiloso. Granos de polen pequeños, 7–10 colporados, con colpos largos.

TRATAMIENTO TAXONÓMICO

Tessiera DC., Prodr. 573. 1830. Lectotipo, aquí designado: *Tessiera lithospermoides* DC.

Diphragmus C. Presl, Bot. Bemerk. 1:80–81. 1844 [reimpr. Abh. Königl. Böhm. Ges. Wiss. ser. 5(3):519. 1845]. **syn. nov.** Tipo: *Diphragmus scaber* C. Presl (≡ *Tessiera lithospermoides* DC.).

Sufrútices de tallos erectos o escandentes, cuadrangulares, pubescentes, pubérulos, escabrosos, glabrescentes o glabros. Estípulas interpeciolares, soldadas en vainas de borde laciniado. Hojas opuestas, sésiles, ovadas, elípticas, oblongas, oblongo-lanceoladas, de base atenuada o redondeada, ápice brevemente atenuado, agudo o mucronado, margen recto o revoluto, papiráceas, haz escabra, envés hirsuto o escabro. Glomérulos florales uni a multifloros, apicales y axilares, con dos brácteas foliáceas. Flores sésiles a pediceladas. Cáliz persistente, 4–6-lobado, lóbulos elípticos, triangulares a estrechamente triangulares, glabros o pubescentes, márgenes ciliados, con coléteres intercalares. Corola infundibuliforme, 4-lobada, blanca, rosada o violeta, externamente glabra o pilosa, internamente con anillo discontinuo de cuatro fascículos de pelos moniliformes cerca de la base y alternos a los lóbulos, lóbulos oval-triangulares, pubescentes en el ápice. Estambres exertos, anteras oblongas, blancas o azuladas. Estilo exerto, hirsuto; estigma capitado-bilobado, hirsuto. Ovario 2 carpelar, turbinado, disco nectarífero 2-lobado. Fruto capsular con dehiscencia septífraga longitudinal, separándose en dos valvas apicales caducas y una porción basal persistente. Las valvas se desprenden en la base del tabique intercarpelar de manera horizontal, coronadas por los lóbulos del cáliz, lóbulos separados (3 y 1, 3 y 2, 3 y 3); porción persistente formada por el septo interlocular y el pedicelo. Semillas plano-convexas, castaño-oscuras, contorno ovado, cara dorsal surcadas o lobuladas, cara ventral con un surco longitudinal cubierto por el estrofíolo persistente rodeado por surcos transversales angostos; testa irregularmente reticulada, paredes periclinales rugosas o microperforadas.

Polen.—Los granos de polen son radiosimétricos, isopolares, suboblados, de ámbito circular y de tamaño grande de 67,7–75 × 58,8–60,4 µm, 13–14 colporados, con colpos cortos, endoabertura con endocíngulo, exina tectado-perforada (Fig. 3, G–I).

Distribución.—Género con dos especies endémicas de México.

Comentarios. Se considera que el género *Diphragmus* fue descripto por Presl a partir del holotipo de *Tessiera lithospermoides*, que se encuentra depositado en PR, por lo tanto aquí se trata a *Diphragmus* como un sinónimo nomenclatural de *Tessiera* (ICBN Art. 14.4).

CLAVE DE LAS ESPECIES DE *TESSIERA*

1. Cáliz 5–6-lobado, lóbulos de 4–5,5(–6) mm long.; tubo corolino externamente piloso; estigma 2 ó 4-lobado ____ **1. Tessiera hexasepala**

1. Cáliz 4-lobado, lóbulos de 0,5–2,5(–3) mm long.; tubo corolino externamente glabro o glabrescente; estigma siempre 2-lobado ____ **2. Tessiera lithospermoides**

Tessiera hexasepala (Borhidi & Lozada) R.M. Salas & E.L. Cabral, comb. nov. (**Figs. 1, 3 G–I, 4**). *Diphragmus hexasepalus* Borhidi & Lozada. Tipo: MÉXICO. Oaxaca: Distrito de Juchitan, Mun. Ixtaltepec, recorrido de Mazahua al Mezquite, ca. 6 km por la carretera 185, a 8 km al NE de La Ventosa, 16°22'N, 94°57'W, 18 Oct 1988, *C. Martínez 2102* (holotipo: MEXU).

Sufrútice 30–100 cm alt., erecto, rastrero o escandente. Tallos tetrágonos, pubérulos, glabrescentes o glabros.

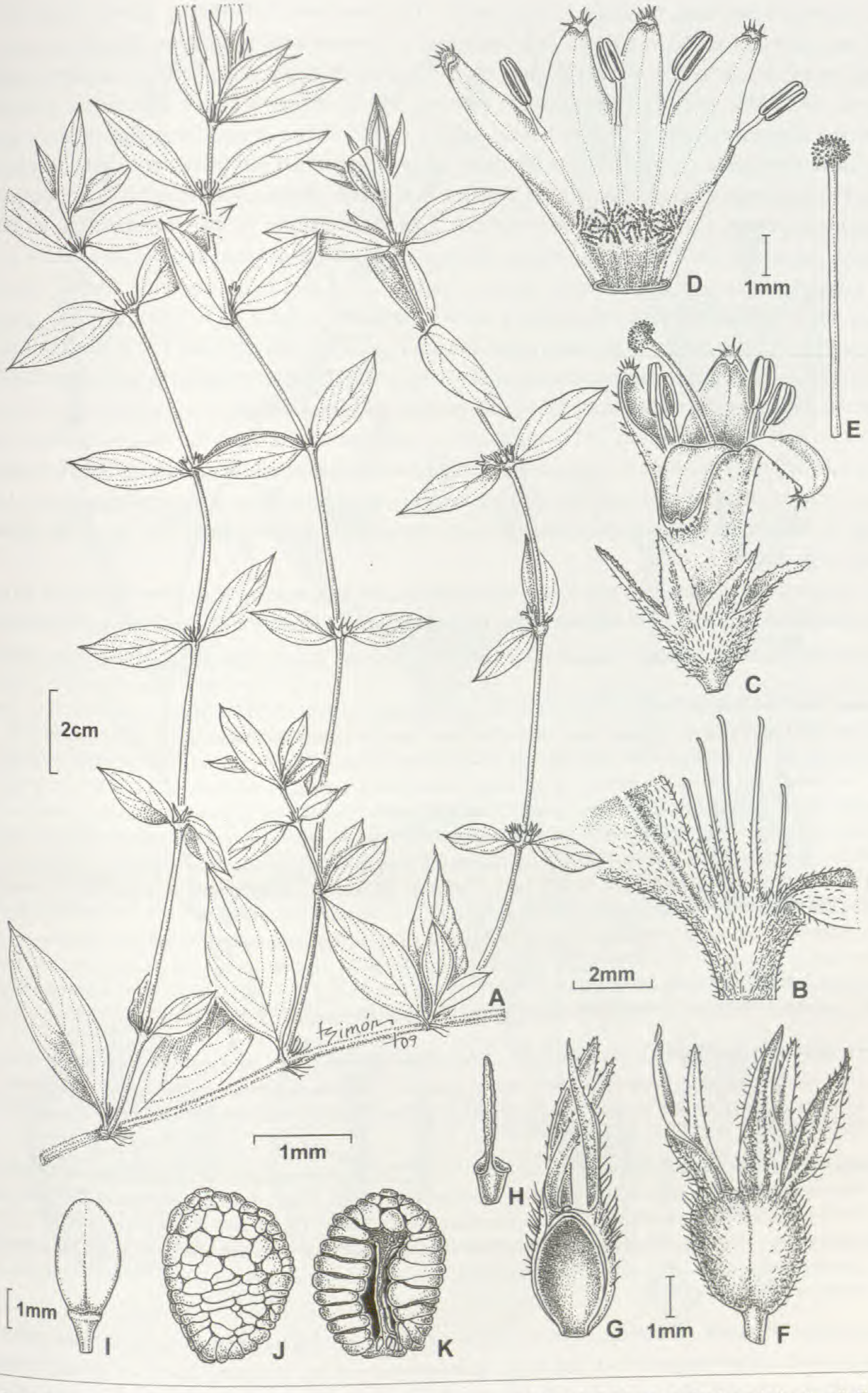


Fig. 1. *Tessiera hexasepala* [*M. Elorsa 3613* (MEXU)]. **A.** Habito. **B.** Vaina estipular con borde laciniado. **C.** Flor. **D.** Interior de corola desplegada. **E.** Estilo. **F.** Fruto. **G.** Vista interna de valva. **H.** Vista lateral de septo intercarpelar. **I.** Vista interna de septo intercarpelar. **J.** Vista dorsal de semilla. **K.** Vista ventral de semilla transversalmente surcada.

Vaina estipular 3 mm long., hirsuta o vellosa, con 8–16 lacinias de 4–10 mm long., pilosas. Hojas 35–70 × 12–25 mm, opuestas, sésiles, ovadas u ovado-lanceoladas, base atenuada, papiráceas, plegado-nervosas, haz escabra, envés hirsuto; con 4–6 pares de nervios. 8–12 glomérulos por rama florífera, apicales y axilares, globosos, 10–15 mm lat., 2 brácteas foliáceas, patentes, ovadas. Flores sésiles o pediceladas, pedicelo de 1 mm long. Hipanto hirsuto. Cáliz 5–6 lobado, lóbulos 4–5,5(–6) mm long., desiguales, ovados o lanceolados, linear-subulados a irregularmente lobulados en la base, pilosos por fuera, internamente papilosos. Corola 5–8 mm long.; tubo corolino blanco, rosado o lila, piloso; lóbulos 3–3,5 mm long., subtriangulares, externamente pilosos, violetas, azulados o morados. Estambres exertos, de menor tamaño que los lóbulos corolinos; filamentos 1,5–2 mm long.; anteras oblongo-elípticas, 1,2–1,5 mm long. Estilo exerto 8–11 mm long., piloso; estigma capitado-bilobado, hirsuto. Cápsula 2,5–3 mm long., obovoide, hirsuta, valvas coronadas por los lóbulos del cáliz en división 3–2, 3–3. Semillas 1,7–1,8 × 1,25–1,35 mm, plano-convexas, contorno elíptico, castaño-oscuras; cara ventral longitudinalmente surcada, con 7–9 surcos transversales alrededor del surco longitudinal; cara dorsal con 3–4 surcos apicales, testa irregularmente retículo-areolada, con células alargadas e irregularmente lobuladas, paredes anticlinales lisas.

Comentarios.—Según Borhidi & Lozada (2006) es una especie endémica del estado de Oaxaca, en los Distritos de Juchitán, Yuatepec y Choapam. Los autores mencionaron que la semilla de *Tessiera hexasepala* presenta una cresta baja dorsal, característica que no pudo ser observada en el material examinado. Ambas especies de *Tessiera* presentan variabilidad en la cara dorsal de la semilla, desde lisa, levemente surcada a lobulada (Fig. 3 A–F).

Es frecuente en bordes de caminos, con vegetación secundaria, en bosque de *Pinus* & *Quercus*, en selvas bajas caducifolias, desde el nivel del mar hasta 2000 m. Florece y fructifica de Septiembre a Diciembre.

Material adicional examinado: **MÉXICO. Oaxaca:** Distrito de Yuatepec, ruta 195, Oaxaca a Tehuantepec, 2000 m, 13 Dic 1980 (fl, fr), *D.H. Lorence & J.R. Cedillos Jrigos 3102* (MEXU); ídem, 13 Dic 1980 (fl, fr), *D.H. Lorence & J.R. Cedillos Jrigos 3103* (MEXU); Distrito de Tehuantepec. Mun. San Carlos de Yuatepec, 1 km al NE de San Miguel Chongos, 16°39'N, 95°58"W, 490 m, 17 Nov 1999 (fr), *E.S. Martínez & J. Catrejón 33000* (MEXU); Mun. Santiago Astata, Barra de la Cruz, 1 km al N, sobre el Río Chacalapa, 15°50'29"N, 95°58'12"W, 30 m, 25 Ene 2001 (fr), *M.C. Elorsa 4202* (MEXU); Mun. Santiago Astata, Barra de la Cruz, 1,2 km W, Arroyo Grande, 15°50'27"N, 95°58'57"W, 105 m, 5 Oct 1999 (fl, fr), *M. Elorsa 2361* (MEXU); Mun. Santiago Astata, Barra de la Cruz, 2 km al S sobre el río, 15°49'57"N, 95°58'03"W, 20 Sep 2000 (fl), *M. Elorsa 3613* (MEXU); Mun. Santiago Astata, Barra de la Cruz, 0,5 km E de la desviación en la carretera costera, 15°50'42"N, 95°58'39"W, 55 m, 10 Oct 1998 (fl, fr), *M. Elorsa 864* (MEXU); Distrito de Juchitán, en los alrededores de la torre repetidora de canal 13, vegetación secundaria, 24 Sep 1984 (fl, fr), *E. Cabrera & R. Torres 7266* (MEXU); Distrito de Choapam, La Chinantla, 15 km al NE de Santiago Choapam, 12 Nov 1983 (fl, fr), *D.H. Lorence et al. 4399* (MEXU); Mun. Chiquihuitlán de Benito Juárez, La concepción, a 2 km en LR al SW de Chiquihuitlán, brecha entre Chiquihuitlán y Santa María de Tlalixtac, 96°45'1,6"N, 17°58'45,9"W, 861 m, s.f. (fl), *C.A.C. Espinosa & G.J. García 1968* (MEXU); Distrito de Pochutla, Mun. San Miguel del Puerto, San Isidro de Chacalapa, 2,5 km N, por la brecha hacia Chongo, 15°56'36"N, 95°56'32"W, 275 m, 23 Nov 1999 (fl, fr), *J.F. Castrejón et al. 728* (MEXU); Mun. San Miguel del Puerto, 1,8 km de Xadani al Achiote, 15°55'47"N, 96°04'04"W, 10 Oct 2001 (fl, fr), *J. Pascual 73* (MEXU); Mun. San Miguel del Puerto, Cascada Copalitilla, 15°54'29,8"N, 96°08'3,3"W, 310 m, 30 Sep 2000, *N.R. Velásquez et al. 533* (MEXU).

Tessiera lithospermoides DC., Prodr. 4:573. 1830. (**Figs. 2, 3 A–F, 4**). *Diphragmus scaber* C. Presl, Bot. Bemerk. 81. 1844. **syn nov**. *Spermacoce lithospermoides* Bartl. ex DC., Prodr. 4:574. 1830. *nomem nudum*. *Staelia scabra* (C. Presl) Standl., Publ. Field Columb. Mus. Bot. Ser. 8: 385. 1931. Tipo: MÉXICO: 1791–1792 (fl, fr), *T.X.P. Haenke s.n.* (holotipo: PR-612185; isotipo: GOET-000144).

Spermacoce asperifolia M. Martens & Galeotti, Bull. Acad. Brux. 11(1):132. 1844. *Borreria asperifolia* (M. Martens & Galeotti) Robinson, Proc. Amer. Acad. Arts 14:409. 1910. *Staelia asperifolia* (M. Martens & Galeotti) C.D. Adams, nomen in herb. Tipo: MÉXICO: south México, humid places near the Pacific Ocean in the State of the Oaxaca, s.f. (fl, fr), *H.G. Galeotti 2626* (holotipo: BR; isotipos: P!, K!, B).

Diphragmus scaber C. Presl var. *minor* Borhidi & Lozada-Pérez. Rubiáceas México 190. 2006. **syn. nov**. Tipo: MÉXICO. Guerrero: Municipio de Acapulco, en las cercanías de la Playa Copacabana, 12 km al SE de Acapulco, 29 Oct 1984, *J.C. Soto Núñez 6850* (holotipo: MEXU; isotipo: FCME n.v.).

Sufrútice 20–150 cm alt., postrado, rastrero, erecto a escandente. Tallos tetrágonos, escabrosos, pubérulos a glabrescentes. Vaina estipular 1–2 mm long., glabrescente, vellosa o hirsuta, con 6–8 lacinias rojizas de 3–6 mm long., pilosas o glabras. Hojas 15–60 × 3–20 mm, opuestas, sésiles o con pseudopecíolos de 1–2,5 mm long., láminas ovadas, elípticas, elíptico-lanceoladas u oblongo-lanceoladas, de ápice mucronado, base

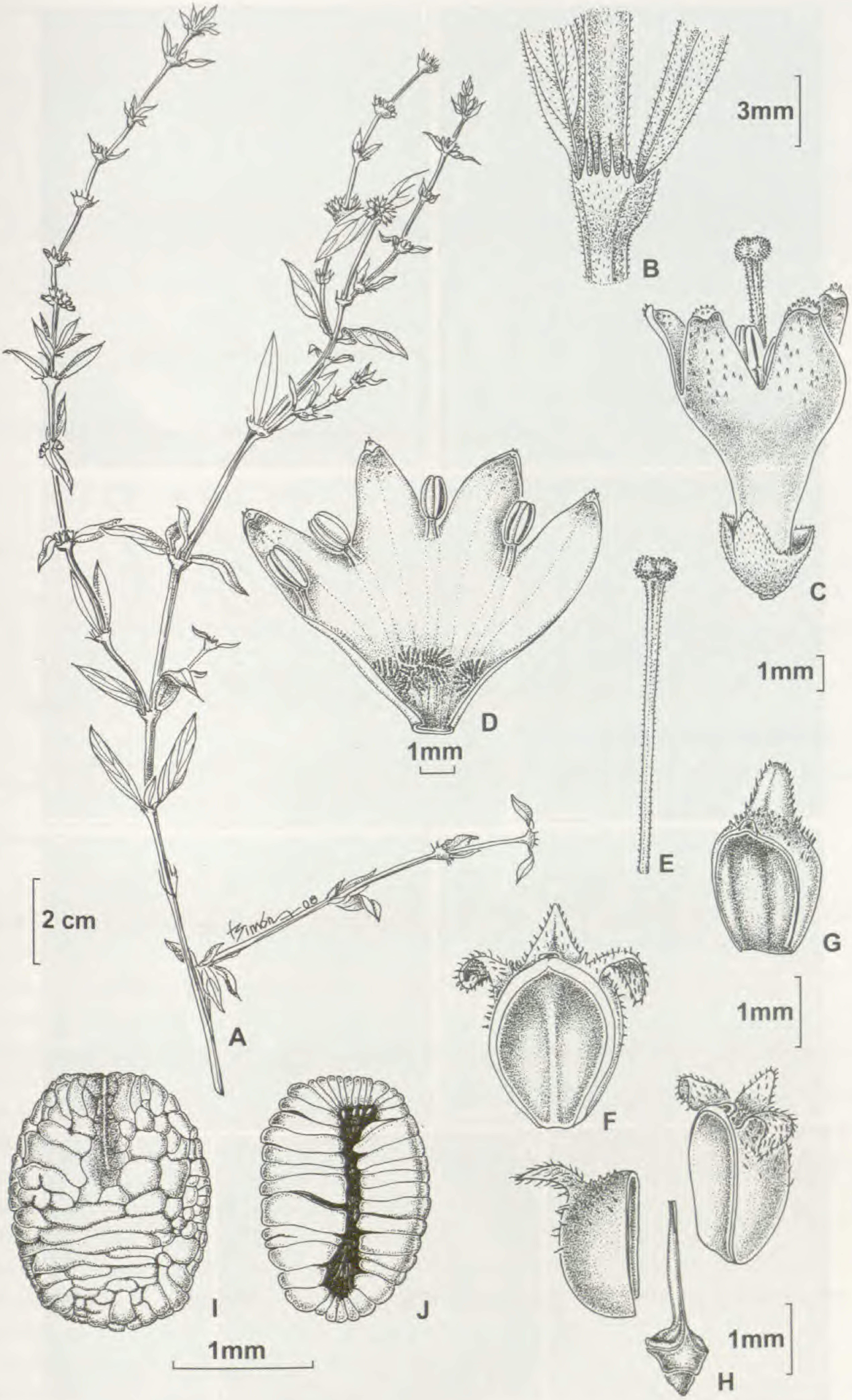


Fig. 2. *Tessiera lithospermoides* [*J.C. Soto Núñez 6850* (MEXU)]. **A.** Habito. **B.** Vaina estipular con borde laciniado. **C.** Flor. **D.** Interior de corola desplegada. **E.** Estilo. **F.** Vista interna de valva con tres lóbulos. **G.** Vista interna de valva con un lóbulo. **H.** Fruto dehiscente en tres partes. **I.** Cara ventral de semilla. **J.** Cara dorsal de semilla.

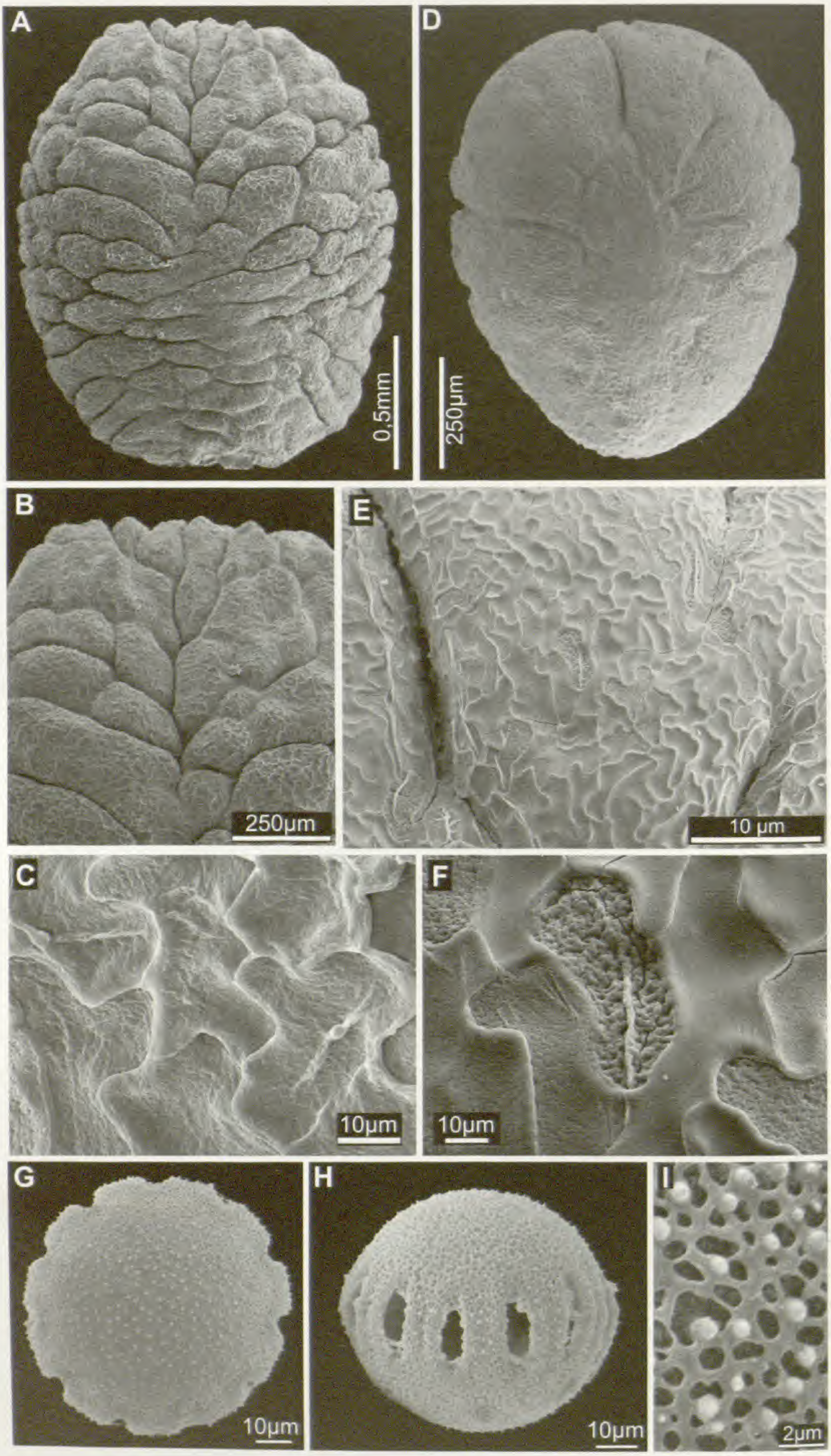
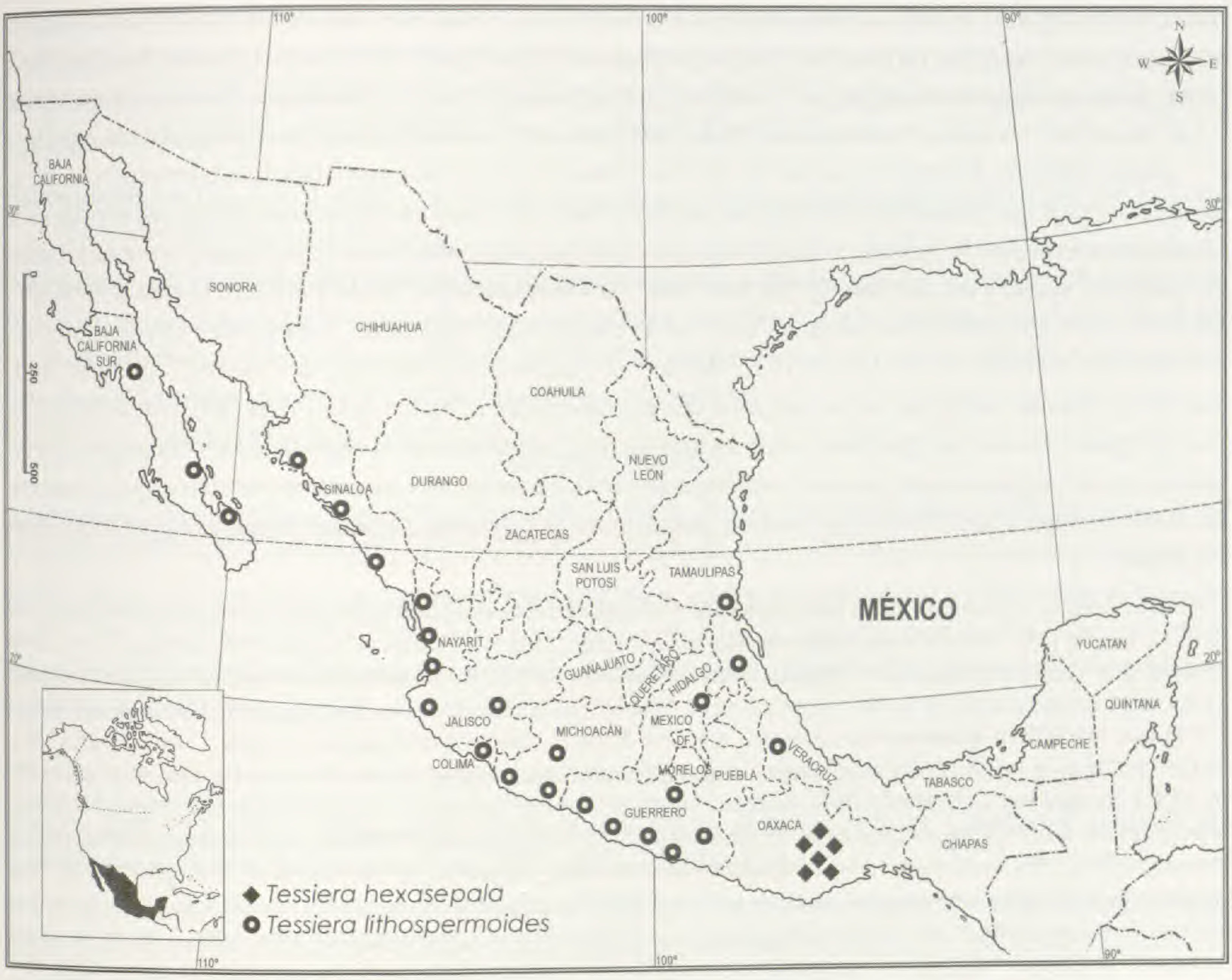

A
0,5mm
D
250µm
B
250µm
E
10 µm
C
10µm
F
10µm
G
10µm
H
10µm
I
2µm

Fig. 3. *Tessiera lithospermoides*. **A–F.** Variación intraespecífica de la semilla. **A.** Cara dorsal de la semilla. **B–C.** Detalle de la exotesta. **D.** Cara dorsal de la semilla. **E–F.** Detalle de la exotesta. *Tessiera hexasepala*. **G–I.** Granos de polen. **G.** Vista polar de grano de polen. **H.** Vista ecuatorial. **I.** Detalle de la exina del apocolpio. [A–C: *J.C. Soto Núñez 6850* (MEXU), D–F: *E. Palmer 397* (K), G–H. *M. Elorsa 3613* (MEXU)].


110°
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BAJA CALIFORNIA
SONORA
CHIHUAHUA
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COAHUILA
NUEVO LEON
DURANGO
SINALOA
ZACATECAS
SAN LUIS POTOSI
TAMAULIPAS
MÉXICO
NAYARIT
GUANAJUATO
QUERETARO
HIDALGO
YUCATAN
QUINTANA
JALISCO
MICHOACÁN
MEXICO
DF
COLIMA
MORELOS
PUEBLA
VERACRUZ
CAMPECHE
TABASCO
GUERRERO
OAXACA
CHIAPAS
◆ Tessiera hexasepala
○ Tessiera lithospermoides

Fig. 4. Distribución de las especies de *Tessiera* en México.

atenuada o redondeada, papiráceas, plegado-nervosas, haz escabra, envés blanco-hirsuto o escabro; con 3–5 pares de nervios. 5–30 glomérulos por rama florífera, apicales y axilares, subesféricos, 10–15 mm lat., 2 brácteas foliáceas, patentes, elípticas a ovadas. Flores sésiles. Hipanto piloso, adpreso-hirsuto o glabrescentes. Cáliz 4 lobado, lóbulos 0,5–2,5(–3) mm long., desiguales, ovados, lanceolados, triangulares, linear-subulados, pilosos, pubérulos a glabros por fuera, glabros o papilosos por dentro. Corola 6–8,5 mm long.; tubo corolino blanco, glabro; lóbulos 3–3,5 mm long., oblongo-ovados, internamente glabros, externamente pilosos, blancos, rosados, violetas o azules. Estambres exertos, de igual o menor tamaño que los lóbulos corolinos; filamentos 1–2 mm long.; anteras oblongo-elípticas 1–1,5 mm long. Estilo exerto 8–10 mm long., piloso; estigma capitado-bilobado, hirsuto. Cápsula 2,5–3 mm long., obovoide, pubescente, glabrescente o glabra; valvas coronadas por los lóbulos del cáliz en división 3–1. Semillas 1,6–1,9 × 1,1–1,5 mm, plano-convexas, contorno elíptico, castaño-oscuras; cara ventral con surco longitudinal angosto, con 7–14 surcos transversales alrededor del surco longitudinal; cara dorsal con numerosos surcos, a menudo confluyendo entre sí, dorso liso o irregularmente lobulado; testa irregularmente retículo-areolada, con células alargadas e irregularmente lobuladas, con paredes periclinales microperforadas o lisas (Fig. 3, A–F).

Distribución y Hábitat.—México: Baja California, Colima, Guerrero, Hidalgo, Jalisco, Michoacán, Nayarit, Oaxaca, Sinaloa, Tamaulipas y Veracruz. De acuerdo a Borhidi (2006) es una especie endémica de México, sin embargo Rose (1891) mencionó un espécimen, bajo *Spermacoce asperifolia*, colectado por Edward Palmer cerca de los Álamos, Texas, Estados Unidos, sin número de colección depositado en el herbario de Kew, material que aparentemente se perdió ya que no se pudo comprobar su existencia en ese herbario.

Comentarios.—Se tuvo la oportunidad de analizar el holotipo de *Diphragmus scaber* var. *minor* y abundante material del herbario de MEXU identificado con ese nombre, se comprobó que las diferencias utilizadas para segregarlo en el rango de variedad no son discretas y que existen plantas con caracteres intermedios. Por lo tanto, en este trabajo se considera a *D. scaber* var. *minor* como un nuevo sinónimo de *Tessiera lithospermoides* y que los caracteres mencionados por Borhidi (2006) son parte de la amplitud morfológica de la especie.

En la colección de negativos de Berlín del Field Museum (http://emuweb.fieldmuseum.org/botany/berResultsList.php), se encuentra el fototipo de un espécimen colectado por Haenke en Perú, con el nombre de *Diodia lithospermoides* K. Schum. Sin embargo, no existe un taxón válidamente publicado con este binomio. Después del análisis de este fototipo se concluye que corresponde a *Tessiera lithospermoides* restringida a México, y que probablemente existe un error en la etiqueta del espécimen. Una posible explicación a este conflicto fue brindada por Pedersen (1972) durante el estudio de dos especies de *Cyperus* L. de Presl. Según este autor, Haenke realizaba envíos parciales de sus colecciones al herbario de Praga (PR), lo que llevó a que sus ejemplares fueran manipulados por personas no familiarizadas con la expedición de Malaspina, permitiendo que en algunos casos fuesen re-etiquetados erróneamente. Por esta razón existen algunas especies de Presl descriptas para Perú y que hasta el presente no se volvieron a colectar (*Cyperus rigens* Presl, sensu Pedersen).

Material adicional examinado: **MÉXICO. Baja California:** S of El valle Perdido, along road to La Junta, 13°41'N, 110°06'W, 08 Nov 1938 (fl, fr), *L. Wiggins 13384* (MEXU). **Baja California Sur:** Mun. Santiago, Casa Vieja, Cañón de la Zorra, NW, Santiago, 450 m, 12 Nov 1986 (fl, fr), *J.L. León 2219* (CIB, MEXU). **Colima:** Colima, Manzanillo, 1891 (fl, fr), *E. Palmer 937* (K); Mun. Colima, Rancho El Jabalí, 22 km NNW of Colima in the SW foothills of the Volcán de Colima; Colima/Jalisco line passes through ranch, 1250 m, 8 Jul 1991(fl, fr), *L.V. Vázquez 785* (MEXU). **Guerrero:** Mun. Acapulco, Mar 1895 (fl, fr), *E. Palmer 253* (K); Guerrero, El Oeste, Cerro Pedregoso, 300 m, 28 Oct 1887 (fl, fr), *E. Palmer 525* (K); Mun. Cuajinicuilapan, a 7 km de Cuajinicuilapan, camino a Pinoteca Nacional, 90 m, 21 Oct 1982 (fl, fr), *E.S. Martinez et al. 2370* (MEXU). Mun. Acapulco, Viveros El Huayacán, La Poza, 12 Sep 1979 (fl), *W. López Formet 945* (MEXU); Mun. Acapulco, La Poza, Viveros El Huayacán, 29 Oct 1979 (fl, fr), *W. López-Forment 973* (MEXU); Mun. Acapulco, La Poza, Viveros el Huayacán, 29 Oct 1979 (fr), *W. López-Forment 987* (MEXU); Mun. Acapulco, Copacabana, 23 Dic 1966 (fl, fr), *W. Boege 498* (MEXU); Mun. Acapulco, Pie de la cuesta, near Acapulco, about sea level, near Lagoon, 18 Ene1955, *M. Carlson 3063* (MEXU); Mun. Azueta, en cerros cercanos de la Playa Linda, 18 km al NO de Zihuatanejo, 90 m, 22 Oct 1985, *J. C. Soto Núnez et al.* 11304 (MEXU); Mun. Coahuayutla, 11 km al N de Colmeneros, camino hacia la unión coahuayutla, 600 m, 25 Oct 1983 (fl, fr), *E.S. Martínez et al. 5221* (MEXU); Mun. Petatlán, 8 km al NE de Coyuquilla, a 3 km del Arroyo Verde, 200 m, 23 Oct 1985 (fl), *J.C. Soto Núnez 11355* (MEXU); Mun. Zihuatanejo, 55 km al NE de Zihuatanejo camino Cd. Altamirano, 520 m, 20 Nov 1983 (fl, fr), *E. Martinez & F. Carrie 5449* (MEXU). **Jalisco:** Jalisco, Sep 1886 (fl, fr), *E. Palmer 397* (K); Mun. Guadalajara, Gravelly soil near Guadalajara, 16 Ago 1893, *C.G. Pringle 4477* (MEXU); Barra de Navidad y Los Huertos, a 1 km de Barra de Navidad, vía Guadalajara, 17 Dic 1965 (fr), *C.M. Delgadillo 45* (MEXU). **Michoacán:** Mun. Aquila, 10 km al NE de Maroata, camino a Pómaro, 120 m, 21 Oct 1985 (fl, fr), *J.C. Soto Nuñez 11259* (MEXU); Along Mex Hwy 37 N of Playa Azul and La Mira near 325 km, 13 Ene 1983 (fl, fr), *J.S. Miller et al. 446* (MEXU, MO); Ruta 37, Playa Azul a Uruapan, ca. de 13 km al N de Playa Azul, 120 m, 20 Ene 1982, *D.H. Lorence et al. 3816* (MEXU). **Nayarit:** Mun. Compostela, Bahía del poblado Platanitos, 21°21'N, 105°14'W, nivel del mar, 12 Nov 1993 (fl,fr), *J.L. Calzada 18974* (CTES, MEXU); Mun. Nayar, P. H. Aguamilpa, ca. 12 km al SE de la Cortina a 4 km de las Adjuntas (Río Huaynamota); 21°N, 104'41°W, 180 m, 6 Oct 1993 (fl, fr), *G.F. Flores et al. 3035* (CTES, MEXU), Mun. Tepic, Alrededores del banco de material de Atonalisco, 360 m, 27 Oct 1991 (fl, fr), *A. Benítez-Paredes 3699* (MEXU); Mun. La Yesca, 6,2 km al SE del puente de Camotlán, camino a Huajimic, 21°36'N, 104°04'W, 1222 m, 26 Oct 1989, *P.L. Tenorio & G.G. Flores 16673* (MEXU); Mun. Ixtlán, 5–6 km de la Terracería Cacalutlán, 21°05'N 104°17'W, 1100 m, 22 Sep 1989 (fl, fr), *O.V. Téllez & A. Salinas 12320* (MEXU). **Oaxaca:** Distrito de Pochutla. Mun. San Miquel del Puerto, Xadani, 2,8 km W por la brecha a San Miguel del Puerto, 15°56'36"N, 96°05'43"W, 610 m, 25 Nov 1999 (fr), *J.F. Castrejón et al. 938* (MEXU); Mun. Chacalapa, camino a Puchutla-Oaxaca, 240 m, 24 Oct 1982 (fl, fr), *E.S. Martinez et al. 2401* (MEXU); Mun. Puerto Ángel, 25 Dic 1974 (fl, fr), *L. Wolfgang Boege 3313* (MEXU); Mun. Jamiltepec, 3 km NE de Flores Magón, 16°23'N, 97°45'W, 400 m, 18 Nov 1982(fr), *P.L. Tenorio et al. 2730* (MEXU). **Sinaloa:** Imala, 1891(fl, fr), *E. Palmer 1734* (K); Mun. San Ignacio, a más de 2 km de Ajoya por la carretera San Ignacio-Ajoya, 250 m, 17 Mar 1985 (fl, fr) *R.V. Aviña 1548* (MEXU); Mun. Mazatlán, in shade of large tree, coastal area 5 mi N of Mazatlán, 17 Oct 1966 (fl, fr), *K.W. Gould 12239* (MEXU); Mun. Mazatlán, Concordia, Loma de la Quebrada, 1800 m, s.f. (fl), *J.O. González 1583* (MEXU). **Tamaulipas:** Mun. Tampico, 8 mi from Tampico on the Mante hwy, 27 Sep 1959 (fl, fr), *J. Graham 4075* (MEXU).

Especies excluidas:

Tessiera pubescens Miq., Stirp. Surinam. Select. 178. 1850. Tipo: SURINAM: Onoribo, 1850, *Focke s.n.* (holotipo: U; isotipo: K).

Comentarios.—El nombre *Tessiera pubescens* fue considerado por Bremekamp (1966) como sinónimo de *Borreria leavis* (Lam.) Griseb., sin embargo este último binomio fue posteriormente rehabilitado y circunscripto a *Spermacoce s. str.* como *S. leavis* Lam. Este cambio se basó en que sus frutos presentan un mericarpo inde hiscente y otro dehiscente y flores con corola muy pequeña, estambres y estilo inclusos (Bacigalupo & Cabral 1999a). Cabral & Bacigalupo (1999) después de analizar el tipo de *T. pubescens*, prefieren considerar a este nombre como sinónimo de *Borreria remota* (Lam.) Bacigalupo & E.L. Cabral por sus frutos con dehiscencia septifraga con ambos mericarpos dehiscentes y estambres y estilo exertos.

Tessiera lanigera DC. 4:573. 1830. Tipo: BRASIL. Distrito Federal: "Brasilia, prope Maria da Souza," *J.E. Pohl 5085* (holotipo: G-DC; isotipo: W!).

Comentarios.—Se excluye a esta especie por presentar caracteres morfológicos y polínicos diferentes a lo establecido para el género *Tessiera* (ver relaciones intergenéricas y claves de géneros afines). Salas & Cabral (en este volumen) ubican a este taxón como parte de un nuevo género distinto de *Tessiera* y *Staelia*, denominado *Planaltina* [=*Planaltina lanigera* (DC.) R.M. Salas & E.L. Cabral.]

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PLANALTINA NUEVO GÉNERO DE LA TRIBU SPERMACOCEAE (RUBIACEAE), ENDÉMICO DEL PLANALTO CENTRAL DE BRASIL Y UNA NUEVA ESPECIE DEL ESTADO DE GOIÁS, BRASIL

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RESUMEN

Durante una revisión de *Staelia*, algunas especies no se ajustaban a los caracteres que definen al género. A partir del estudio taxonómico de *Staelia*. También se encontró que algunas especies fueron transferidas de otros géneros, particularmente de *Tessiera* DC. Este último género fue descrito sobre dos especies, *T. lithospermoides* de México y *T. lanigera* de Brasil. Schumann trató a *Tessiera* como sección de *Staelia*, incluyendo a *Staelia lanigera* (=*T. lanigera*) y a una nueva especie, *S. capitata*. Recientemente, *T. lithospermoides* fue elegida como lectotipo del rehabilitado género *Tessiera* y se segregó a la especie de Brasil, *T. lanigera*. Con el fin de establecer los límites de cada taxón incluido en este trabajo, se estudiaron los tipos nomenclaturales, la morfología polínica, carpológica y seminal de cada especie. Los resultados muestran que las especies previamente incluidas en *Staelia* secc. *Tessiera* tienen fuertes diferencias con las de la secc. *Staelia* y con *T. lithospermoides*. Consecuentemente *S. lanigera* (=*Tessiera lanigera*) y *S. capitata* deben ser segregadas en un nuevo género, distinto de *Staelia* y de *Tessiera*. A este nuevo taxón se lo denomina *Planaltina*, porque todas sus especies están restringidas al Planalto Central de Brasil. Se discute la relación de *Planaltina* y los géneros relacionados. Todas las especies son descritas e ilustradas. Se presentan también claves ilustradas para distinguir los géneros más afines de la tribu Spermacoceae.

PALABRAS CLAVE: *Planaltina* nov. gen., *P. myndeliana*, Spermacoceae, Cerrado, Plan Alto Central, Brasil

ABSTRACT

In our revision of *Staelia* Cham. & Schltdl., we found several species that did not exhibit the characters of the genus. Some species were transferred into the *Staelia* from other genera, particularly *Tessiera*. The latter genus was described with two species, *T. lithospermoides* from Mexico and *T. lanigera* from Brazil. Schumann treated *Tessiera* as a section of *Staelia* including *Staelia lanigera* (=*T. lanigera*) and a new species *S. capitata*. Recently, *T. lithospermoides* was designated as the lectotype of *Tessiera*, and *T. lanigera* was excluded from this group. To clarify the taxonomy of these taxa, the nomenclatural types, pollen, fruit, and seed morphology of each species were analyzed. The results indicate that species previously placed in *Staelia* sect. *Tessiera* are different from those included in sect. *Staelia*, and also differ from *T. lithospermoides*. Consequently, *S. lanigera* and *S. capitata* are segregated to a new genus, *Planaltina*, because all the species are endemic to the central Brazilian highlands. The relationships between *Planaltina* and related genera of Spermacoceae are discussed. All the species are described and illustrated, and an illustrated key to distinguish the genera is presented.

KEY WORDS: *Planaltina* nov. gen., *P. myndeliana*, Spermacoceae, Cerrado, Central Brazilian highlands, Brazil

INTRODUCCIÓN

El género *Staelia* Cham. & Schltdl. fue descrito por Chamisso & Schlechtendal (1828), basado en *S. thymoides* Cham. & Schltdl., del sur de Brasil. Se lo diferenció de los demás géneros de la tribu Spermacoceae s. str., por el cáliz 2-lobado, por la corola infundibuliforme y por el fruto capsular con dehiscencia oblicua. Candolle (1830) reconoció a *Staelia* y describió dos nuevas especies: *S. galioides* DC. y *S. reflexa* DC. del Estado de Goiás, Brasil. En la misma obra el autor describió al género *Tessiera* DC., basado en *T. lanigera* DC. y *T. lithospermoides* DC., de Brasil y México, respectivamente.

Autores como Endlicher (1838), Dietrich (1839) y Steudel (1841) aceptaron el status genérico de *Staelia* y *Tessiera* y reconocieron a las especies hasta ese momento descritas. Sin embargo, Hooker (1873) colocó a *Tessiera* bajo la sinonimia de *Spermacoce* L., por considerar que el indumento lanoso, característico de la

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especie brasileña, se puede observar en algunas especies de *Spermacoce*. Pocos años después, Baillon (1880) incluyó a *Staelia* y *Tessiera* como sinónimos de *Spermacoce*, cuyo amplio concepto abarcaba también a *Mitracarpus* Zucc. ex Schult. & Schult. f., *Hypodematium* A. Rich., *Diodia* L., *Dasycephala* DC. y *Octodon* Thonn.

Schumann (1888a) en oposición al concepto de Hooker y de Baillon, re-delimitó al género *Spermacoce* y rehabilitó a *Staelia*, *Mitracarpus* y *Diodia*. El autor propuso separar a *Tessiera* de *Spermacoce* y transferirlo a *Staelia* como una sección, ampliando de esta manera el concepto del género. Este concepto fue reafirmado por Schumann en sucesivos trabajos (Schumann 1888b, 1891; Delprete et al. 2005).

Schumann (1888a) en reconoció para Brasil a diez especies, cuatro nuevas: *Staelia aurea* K. Schum., *S. capitata* K. Schum., *S. cathechosperma* K. Schum. y *S. vestita* K. Schum. y tres nuevas combinaciones, *S. lanigera* (DC.) K. Schum. (=*Tessiera lanigera*), *S. thymbroides* (Mart. & Zucc.) K. Schum. (=*Psyllocarpus thymbroides* Mart. & Zucc.) y *S. virgata* (Link ex Roem. & Schult.) K. Schum. (=*Spermacoce virgata* Link ex Roem. & Schult.). En la misma obra el autor propone reunir a las especies en tres secciones, basado en el hábito, en las hojas, forma y textura, en el tipo de estigma y en las semillas, en su permanencia o no en las valvas después de la dehiscencia. Schumann diferencia a la primera sección, *Tessiera* (DC.) K. Schum., por presentar estigma capitado, tallos con base leñosa, hojas oblongas, ovadas o lanceoladas y coriáceas, a la segunda sección, *Anthospermopsis* K. Schum., por el estigma bífido, hojas pequeñas, lineares y coriáceas y por las semillas que permanecen incluidas en las valvas después de la dehiscencia. La tercera sección, *Staelia*, fue separada por el estigma bífido, hojas lineares, papiráceas y semillas que se separan de las valvas después de la dehiscencia.

Kirkbride (1997), después de analizar el tipo de dehiscencia del fruto de la sección monotípica *Anthospermopsis*, la eleva al status genérico: *Anthospermopsis* (K. Schum.) J.H. Kirkbr.

Durante la revisión del género *Staelia*, se comprobó que las especies agrupadas en la sección *Tessiera* de Schumann, no se ajustaban a la definición de *Staelia* propuesta por Chamisso & Schlechtendal. A fin de establecer los límites de los taxones estudiados, se analizaron caracteres diferenciales de la dehiscencia del fruto, de la forma y escultura de la semilla y de la morfología de los granos de polen. Los caracteres morfológicos diferenciales entre de estos dos grupos también fueron observados por Dessein (2003).

Con respecto a las dos especies de *Tessiera sensu* Candolle, se observó que el fruto coincide en el plan básico de dehiscencia descrito para el género, sin embargo se encontraron marcadas diferencias en caracteres florales, seminales y polínicos. Por esta razón se rehabilitó a *Tessiera* a nivel de género, se seleccionó a *T. lithospermoides* como especie tipo y se segregó a *T. lanigera* fuera de la circunscripción de *Tessiera* (Salas & Cabral, en este volumen).

En este trabajo se comprobó que las especies incluidas por Schumann bajo la sección *Tessiera*, presentan caracteres florales, polínicos y vegetativos en común y que a su vez son diferentes de los descritos para la especie tipo de *Staelia*. Se considera que las diferencias encontradas son suficiente soporte para segregar a las especies de la sección *Tessiera* de Schumann en un nuevo género. Por esta razón se describe a este nuevo género al que denominamos *Planaltina* R.M. Salas & E.L. Cabral. Se lo relaciona con los géneros más afines de la tribu Spermacoceae y se efectúan dos nuevas combinaciones. Se describe también una nueva especie endémica del estado de Goiás.

RELACIONES INTERGENÉRICAS

De los géneros de tribu Spermacoceae s. str. (Robbrecht 1988), *Planaltina* se relaciona morfológicamente con los siguientes géneros americanos: *Anthospermopsis*, *Mitracarpus*, *Psyllocarpus* Mart. ex Mart. & Zucc., *Staelia* y *Tessiera*.

Anthospermopsis es un género monotípico, endémico del estado de Bahía, Brasil (Kirkbride 1997). Este género coincide con *Planaltina* en la dehiscencia septífraga longitudinal del fruto, separado en tres piezas, dos apicales caducas y una intermedia persistente. Sin embargo, *Anthospermopsis* difiere en la pieza media, porque está formada únicamente por una porción interna de los tabiques intercarpelares, además las piezas apicales se liberan reteniendo en su interior a la semilla por un reborde remanente del tabique intercarpelar (Fig. 1). En *Planaltina* las valvas se liberan de manera independientes a las semillas. *Anthospermopsis* presenta granos de polen pequeños, tectado-perforados, 7–8 colporados y colpos largos.

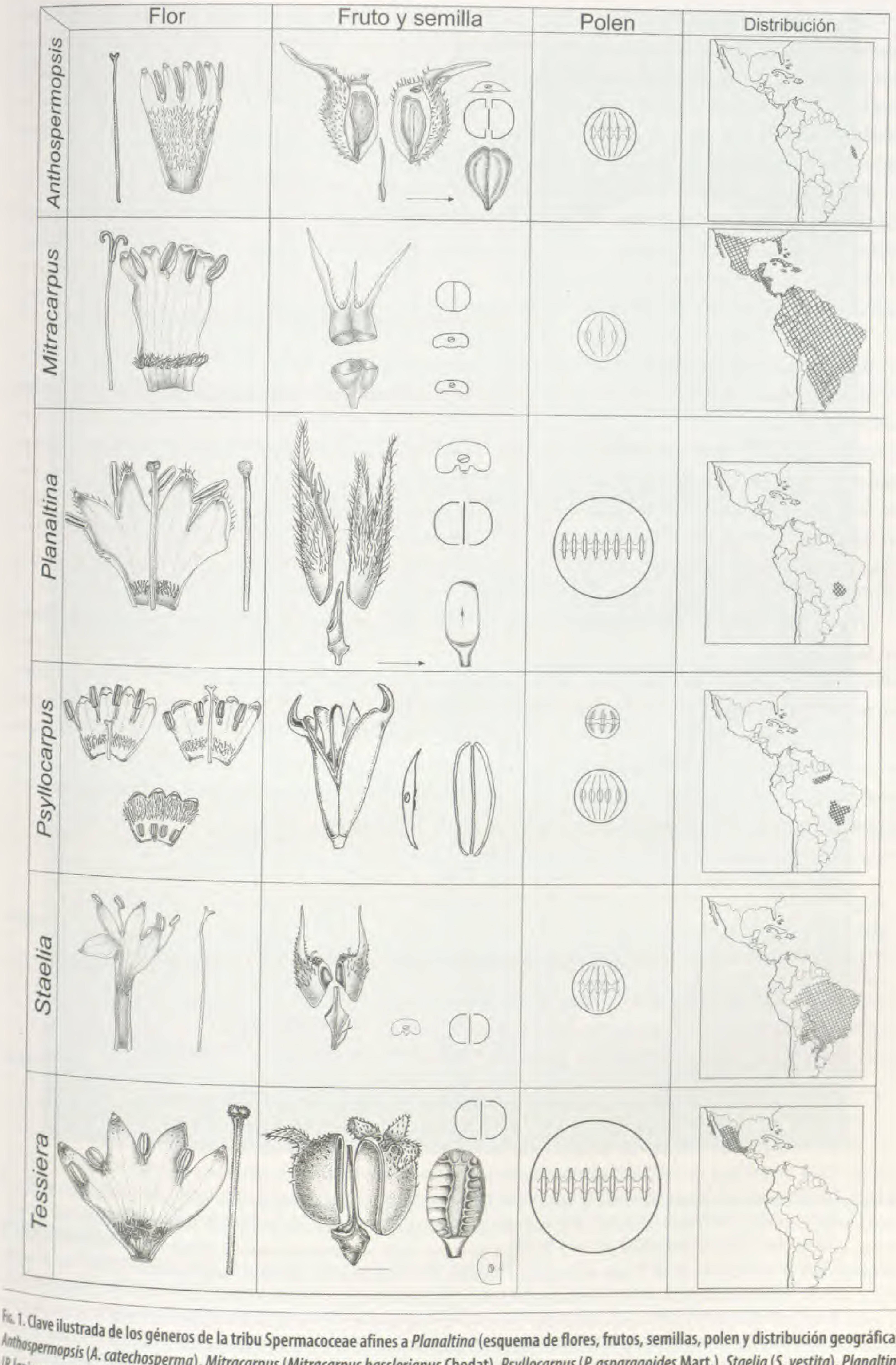
Flor
Fruto y semilla
Polen
Distribución
Anthospermopsis
Mitracarpus
Planaltina
Psyllocarpus
Staelia
Tessiera

Fig. 1. Clave ilustrada de los géneros de la tribu Spermacoceae afines a *Planaltina* (esquema de flores, frutos, semillas, polen y distribución geográfica): *Anthospermopsis* (*A. catechosperma*), *Mitracarpus* (*Mitracarpus hasslerianus* Chodat), *Psyllocarpus* (*P. asparagoides* Mart.), *Staelia* (*S. vestita*), *Planaltina* (*P. lanigera* corola y estilo; *P. capitata* estilo, estigma capitado y fruto) y *Tessiera* (*T. lithospermoides*).

Mitracarpus es un género de americano con alrededor de 50 especies (Souza 2008) y se diferencia por la dehiscencia circuncisa del fruto, que se separa en dos piezas, una mitad superior entera y una mitad basal persistente. La pieza basal presenta un corte transversal y está formada por la mitad inferior de los carpelos y de los tabiques intercarpelares (Fig. 1). *Mitracarpus* se diferencia de *Planaltina*, también por las semillas pequeñas que carecen de surcos transversales y que presentan la cara ventral con una depresión cuadrangular, o con forma de X o de Y invertida.

Psyllocarpus es endémico de Brasil y cuenta con nueve especies, distribuidas en dos subgéneros (Kirkbride 1979; Cabral & Bacigalupo 1997). La dehiscencia del fruto es septífraga y longitudinal, se separa también en tres piezas, dos apicales caducas y una pieza intermedia persistente. A diferencia de *Planaltina*, el fruto de *Psyllocarpus* está comprimido lateralmente en dirección al tabique intercarpelar. Las especies de *Psyllocarpus* presentan además semillas fuertemente aplanadas que carecen de surcos, a menudo aladas (Fig. 1).

Staelia es un género sudamericano con 17 especies (Salas & Cabral 2010), se diferencia de *Planaltina* por presentar una dehiscencia del fruto longitudinal y oblicua que se separa en tres piezas, dos apicales caducas o valvas y una basal persistente. La dehiscencia comienza longitudinalmente desde el ápice hasta la mitad y desde allí sigue una línea oblicua hacia abajo. La porción persistente está formada por el tabique intercarpelar, el pedicelo y la porción inferior de las paredes de los carpelos, mientras que en *Planaltina* está formada únicamente por los tabiques intercarpelares y el pedicelo (Fig.1, 2 A–D). Las hojas en *Staelia* son siempre pseudoverticiladas por la presencia de braquiblastos en las axilas y con nervios secundarios inconspicuos. Presenta granos de polen pequeños, tectado-perforados, 7–10 colporados y colpos largos (Fig. 2 E–F).

Tessiera es un género endémico de México con 2 especies (Salas & Cabral, en este volumen). Coincide con *Planaltina* en el plan básico de dehiscencia, en ambos es septífraga y longitudinal, separándose en dos valvas apicales caducas y una porción basal persistente. *Tessiera* se diferencia de *Planaltina* por sus flores, que presentan el interior de la corola un anillo discontinuo de pelos formado por cuatro fascículos de pelos moniliformes, estilo piloso adpreso y estigma hirsuto. Las semillas tienen la cara ventral plana, cubierta seminal con patrón celular irregularmente reticulado. Al igual que *Planaltina*, los granos de polen son grandes con exina tectado-perforada, uniformemente espinulada, sin embargo el polen de *Tessiera* es 13–14 colporado, con perforaciones más grandes, densas y sin espesamientos (Fig. 1, 2 G–N).

CLAVE PARA DIFERENCIAR GÉNEROS DE SPERMACOCEAE S. STR. AFINES DE *PLANALTINA*

1. Fruto con dehiscencia circuncisa. Lóbulos del cáliz desiguales, dos menores y dos mayores. Semilla con depresión ventral cuadrangular, en forma de X o de Y invertida ________ **Mitracarpus**

1. Fruto con dehiscencia septífraga longitudinal, longitudinal-oblicua o longitudinal-horizontal. Lóbulos del cáliz de igual tamaño (excepto en *Planaltina*). Semilla con cara ventral surcada longitudinalmente o plana.

  2. Fruto lateralmente comprimido. Semillas aplanadas, aladas, cara ventral sin surcos. Flores homostilas o heterostilas. Lámina foliar cilíndrica o aplanada. Granos de polen tectado-espinulados, con espínulas concentradas alrededor de los colpos (flores homostilas), tectado-perforados o microreticulados con retículo doble y uniformemente espinulados en flores heterostilas ________ **Psyllocarpus**

  2. Fruto subesférico u ovobado. Semillas no aplanadas, no aladas, cara ventral con surcos (brevemente aladas en *Anthospermopsis*). Flores siempre homostilas. Lámina foliar aplanada. Granos de polen tectado-perforados.

    3. Fruto subesférico con dehiscencia longitudinal, con una pieza intermedia cordada y con dos piezas apicales que se liberan reteniendo en su interior a la semilla por un reborde remanente del tabique intercarpelar. Semilla brevemente alada. Interior de la corola con una franja de pelos desde el tercio inferior del tubo hasta la base de los lóbulos ________ **Anthospermopsis**

    3. Fruto obovado con dehiscencia longitudinal-horizontal o longitudinal-oblicua, con una pieza intermedia elíptica u obovada y dos piezas apicales que se liberan independientes a las semillas. Semillas no aladas. Interior de la corola con anillo de pelos moniliformes ubicados en la mitad inferior del tubo.

      4. Hojas pseudoverticiladas, lámina con nervios secundarios inconspicuos. Lacinias de la vaina estipular glabras. Fruto con dehiscencia longitudinal y oblicua. Pieza basal del fruto formada por los tabiques intercarpelares, el pedicelo y la porción inferior de los carpelos. Cáliz 2-lobado, lóbulos iguales.

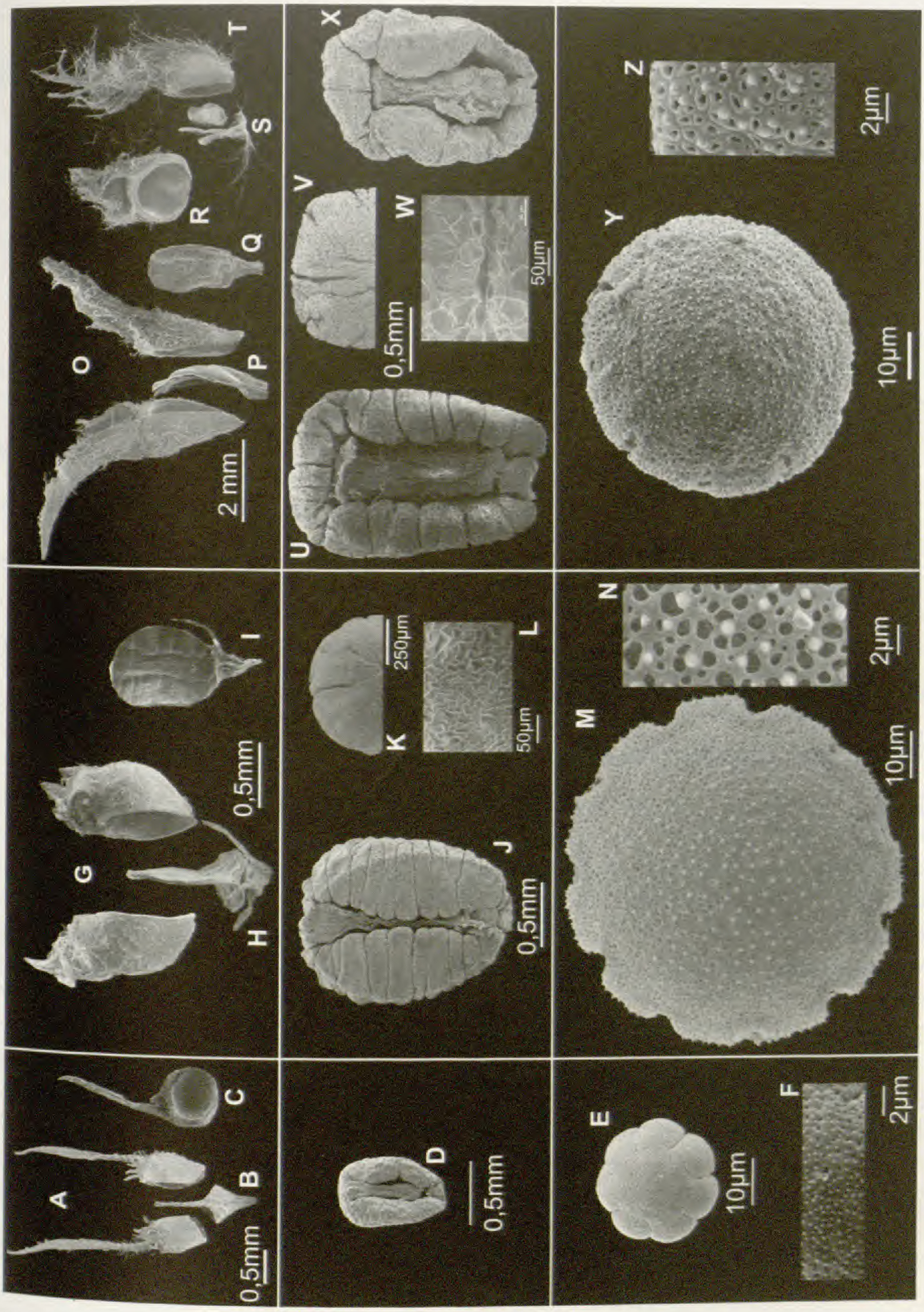

Fig. 2. Cuadro comparativo (fotos MEB) de los géneros *Staelia*, *Tessiera* y *Planaltina*. **A–F.** *Staelia*. **A.** Valvas del fruto. **B.** Septo intercarpelar y base de carpelos. **C.** Vista interna de valva. **D.** Vista ventral de semilla. **E.** Vista polar de grano de polen. **F.** Detalle de la exina. **G–N.** *Tessiera*. **G.** Valvas del fruto. **H.** Septo intercarpelar. **I.** Vista interna del septo intercarpelar. **J.** Vista ventral de semilla. **K.** Vista dorso-apical de semilla. **L.** Detalle de la cubierta seminal. **M.** Vista polar de grano de polen. **N.** Detalle de mesocolpio. **O–Z.** *Planaltina*. **O.** Valvas del fruto. **P.** Septo intercarpelar. **Q.** Vista interna del septo intercarpelar. **R–T.** Fruto. **R.** Vista interna de valva. **S.** Septo intercarpelar y semillas desigualmente desarrolladas. **T.** Vista lateral de valva. **U.** Vista ventral de semilla. **V.** Vista dorso-apical de semilla. **W.** Detalle de la cubierta seminal. **X.** Vista ventral de semilla. **Y.** Vista polar de grano de polen. **Z.** Detalle de exina. A–F. *Staelia thymoides* [*Cabral, E.L. et al. 168* (CTES)]. G-N. *Tessiera lithospermoides*. [G–I, K, L. *Palmer, E. 397* (K); J, M, N. *Soto Núñez, J.C. 6850* (MEXU)]. O–Q, U–W. *Planaltina capitata* [*Hatschbach, G. & J.M. Silva 60036* (CTES)]. R–T, X. *Planaltina lanigera* [*Hatschbach, M. et al. 64238* (CTES)]. Y, Z. *Planaltina myndeliana* [Holotipo, *Hatschbach, G. & J.M. Silva* 60266 (CTES)].

Corola comúnmente blanca. Estigma bífido. Semillas pequeñas (0,8–1,2 mm), cara ventral sin surcos transversales (excepto *Staelia tocantinsiana* R.M. Salas & E.L. Cabral). Granos de polen pequeño, ectocolpos largos ______ **Staelia**

4. Hojas opuestas, lámina con 4–7 pares secundarios de nervios evidentes. Lacinias de la vaina estipular pilosas. Fruto con dehiscencia longitudinal. Pieza basal formada por los tabiques intercarpelares y el pedicelo. Cáliz 4–7-lobado, con lóbulos iguales o desiguales. Corola blanca, rosada, violeta o lilacina. Estigma capitado o capitado-bilobado. Semillas grandes (1,5–2,5 mm), cara ventral con (3–) 6–12 surcos transversales, prolongados hacia el dorso (excepto en *Planaltina lanigera*). Granos de polen grandes, ectocolpos cortos.
    5. Tallos escabros, pubérulos, glabrescentes o glabros, vaina estipular hirsuta o vellosa, hojas papiráceas a subcoriáceas con la haz escabrosa, envés hirsuto. Interior del tubo corolino con un anillo discontinuo de 4 fascículos de pelos alternos a los lóbulos. Disco nectarífero 2-lobado. Granos de polen suboblados, 13–14 colporados, exina con perforaciones sin espesamientos. Fruto con ambos carpelos igualmente desarrollados. Septo intercarpelar membranáceo, con impresiones de las semillas. Cara ventral de la semilla plana, dorso con surcos angostos transversales o lobulado. Cubierta seminal irregularmente reticulada, paredes periclinales microperforadas ______ **Tessiera**
    5. Tallos lanosos, hirtos o híspidos, a veces glabro en tallos basales, vaina estipular y hojas levemente crasas, coriáceas cuando secas, densamente lanosas o híspidas. Interior del tubo corolino con un anillo contínuo de pelos. Disco nectarífero entero. Granos de polen esferoidales, 10–11 colporados, perforaciones espesadas. Fruto con un carpelo más desarrollado que el otro. Septo intercarpelar coriáceo, sin impresiones de las semillas. Cara ventral de la semilla con surcos transversales, dorso sin surcos transversales (excepto *P. capitata*). Cubierta seminal regularmente retículo-foveada o retículo-areolada, con células poliédricas de paredes periclinales lisas ______ **Planaltina**

Planaltina R.M. Salas & E.L. Cabral, gen. nov. ESPECIE TIPO: *Planaltina myndeliana* R.M. Salas & E.L. Cabral.

Staelia secc. *Tessiera* (DC.) K. Schum., in Mart., Fl. Bras. 6(6):72–73. 1888. ESPECIE TIPO: *Staelia capitata* K. Schum. (LECTOTIPO, aquí designado). *Tessiera* auct. non DC.: K. Schum., in Mart., Fl. Bras. 6(6):72. 1888.

Sufrutex erectus, caulibus subteretis, folia sessilia opposita, elliptica, lanceolata, oblongo-ovata vel ovata, plicato-nervosa, coriaceis, lanuginosa, hispida vel glabrata. Vagina stipularis lanuginosa vel pilosa, laciniis plurimis ciliolatis. Inflorescentiae in glomerulis axillaribus, cum 2–4 bractea foliacea per verticillus. Flores sessilis vel pedicelatis, isomorfi. Calyx 4–7-merus tubo conspicuus. Corolla infundibuliformis 4-loba, alba. Stamina 4, alba vel caelurea. Stylo corollae aequilongo, filiformis, glaber. Stigma capitatus vel capitato-bilobatus, papilosus. Capsula obovata, dehiscentia septifraga longudinalis et transversa, in 2 valvis nulli obnoxius separatus, valvis cum calycis segmentis persistentibus in 1 et 3, 2 et 2, 2 et 3, 3 et 3 vel 3 et 4 divisis coronatus, dissepimento integro coriaceis persitentibus. Semina subellipsoidea, oblonga vel obovoidea, fusca vel purpureo-nigra, facies ventrali anguste sulcata et/vel ruminata, facies dorsali anguste sulcata vel laevigata. Testa reticulo-areolata vel reticulo-foveata, paries laevigata.

Sufrútice de tallos erectos, subcilíndricos, lanosos, hirtos o híspidos. Estípulas interpeciolares, soldadas en vaina de borde laciniado. Hojas opuestas, sésiles, elípticas o angostamente elípticas, elíptico-lanceoladas, oblongas, oblongo-lanceoladas, ovadas, levemente crasas, coriáceas cuando secas, plegado-nervadas. Glomérulos multifloros, apicales y axilares, con 2 (–4) brácteas foliáceas. Flores sésiles o pediceladas. Cáliz 4–7-lobado, lóbulos triangulares a angostamente triangulares, unidos en la base formando un tubo. Corola infundibuliforme, 4-lobada, blanca, externamente pubescente o pubérula, internamente con anillo contínuo de pelos moniliformes en el tercio inferior. Estambres exertos; anteras blanquecinas o azuladas. Estilo filiforme; estigma capitado o capitado-bilobado, papiloso, exerto. Hipanto turbinado; disco nectarífero entero. Fruto capsular con dehiscencia septífraga longitudinal, separándose en dos valvas apicales caducas y una porción basal persistente. Las valvas se desprenden en la base del tabique intercarpelar de manera oblicua u horizontal, coronadas por los lóbulos del cáliz en división 2–2, 2–3, 1–3, 3–3 o 3–4. Semilla subelipsoide oblongas u obovoide, castaño-oscuras a nigrescentes, cara dorsal con o sin surcos, cara ventral no surcada o con surcos transversales que se prolongan hacia la cara dorsal. Cubierta seminal con células retículo-foveadas o retículo-areoladas, paredes periclinales lisas.

Polen.—Los granos de polen son radiosimétricos, isopolares, esferoidales y de ámbito circular, de tamaño grande, de 61,5–65 × 60–64,5 µm, 10–11 colporados, colpos cortos, endoaberturas lalongadas unidas lateralmente. Exina tectado-perforada, perforaciones con márgenes espesados (Fig. 2, Y–Z).

Etimología.—El nombre propuesto fue elegido porque las tres especies aquí reconocidas habitan el Planalto Central de Brasil, región donde existe además un municipio denominado de igual manera perteneciente al Distrito Federal de Brasil.

Comentarios.—Género endémico de Brasil, las tres especies aquí reconocidas viven exclusivamente en el Planalto central, en los estados de Goiás, Minas Gerais y en el Distrito Federal, entre los 800 y 1.200 m de altitud.

CLAVE DE LAS ESPECIES DE *PLANALTINA*

1. Cáliz 4-lobado. Cara ventral de la semilla con 9–12 surcos transversales alrededor del surco longitudinal, cara dorsal con 3–4 surcos en la mitad superior. Brácteas involucrales recurvadas **1. P. capitata**

1. Cáliz 5–7-lobado. Cara ventral de la semilla con 2–3 surcos transversales alrededor del surco longitudinal, cara dorsal sin surcos. Brácteas involucrales patentes.

  2. Tallos, vaina estipular y hojas lanosas, haz foliar a veces glabra, lámina ovada. Rama florífera con 18–22(–30) glomérulos. Fruto, mitad superior lanoso, el resto glabro. Lóbulos del cáliz 1–1,5 mm long. Corola 4–5 mm long **2. P. lanigera**

  2. Tallos vellosos o pubérulos, vaina estipular vellosa, hojas híspidas, lámina estrechamente elíptica o elíptico-lanceolada. Rama florífera con 2–4 glomérulos. Fruto pubescente. Lóbulos del cáliz 4–6 mm long. Corola 7–7,5 mm long. **3. P. myndeliana**

DESCRIPCIÓN DE LAS ESPECIES

1. Planaltina capitata (K. Schum.) R.M. Salas & E.L. Cabral, comb. nov. (**Figs. 2 O–Q, U–W, 3**). *Staelia capitata* K. Schum. in Mart., Fl. Bras. 6(6):72. 1889. Tipo: BRASIL. Minas Gerais: "inter Alegre et fluvium São Francisco," Set 1834, *L. Riedel, 2880* (Lectotipo, aquí designado: K!, iso lecotipo: BR!).

Sufrútice de 30–180 cm alt., erecto; tallos subcilíndricos, vináceos, densamente blanco-lanosos a glabros; entrenudos 1,5–4,5 cm. Vaina estipular lanosa 2,5–4 mm de long., con 7–12 lacinias de 4–13 mm long., ciliadas. Hojas 25–77 × 6–18 mm, sésiles, elípticas, elíptico-laceoladas u oblongas, ápice acuminado o apiculado, base atenuada o cordada, levemente crasas, coriáceas cuando secas, plegado-nervosas, con 4–6 pares de nervios subopuestos secundarios, prominentes en el envés, haz pubescente o glabra, envés densamente lanoso, margen revoluto. Inflorescencias subesféricas, 10–21 mm lat., apicales y axilares, 1–5(–10) glomérulos por rama florífera, 2–4 brácteas foliáceas, recurvadas. Flores sésiles. Hipanto obovoide, tomentoso. Cáliz 4-lobado, lóbulos de 2–4 × 0,5–1 mm, angostamente triangulares, desiguales, 2 mayores y 2 menores, acuminados, externamente blanco-pubescentes, con 2–3 dentículos intercalares no glandulares. Corola 6–9 mm, infundibuliforme, blanca, externamente pilosa. Estambres exertos, de igual tamaño al de lóbulos de la corola; anteras de 1,4–1,8 mm., azuladas. Estilo 6–6,5 mm long.; estigma capitado o capitado-bilobado, papiloso. Cápsula 2,5–3 × 1,5–2 mm, obovoide, pilosa; valvas coronadas por los lóbulos del cáliz en división 2–2 ó 3–1, con tubo calicino 2–3 mm long. Semillas 1,3–2 × 1,1–2 mm, elipsoides, plano-convexas, castaño-oscuras, cara ventral surcada con márgenes ruminados, con 9–12 surcos alrededor del surco longitudinal, cara dorsal con 3–4 surcos en la mitad superior. Cubierta seminal retículo-foveadas, con células poliédricas, paredes periclinales lisas.

Distribución, hábitat y ecología.—Especie endémica de Brasil, común en el Distrito Federal y en el estado de Goiás. Habita en el Cerrado estricto, Cerradão, Campo Cerrado, Campo Sujo y Campo Rupestre. Florece desde agosto hasta noviembre, predominante en setiembre-octubre. Fructifica en casi todos los meses del año, principalmente de febrero a marzo.

Comentarios.—Esta especie presenta a lo largo de su distribución variaciones en el tamaño de la planta y en el de las hojas, en la forma e indumento de la lámina y en el indumento del tallo. Se observó además que las valvas del fruto se desprenden a menudo unidas en el ápice, contrario a lo indicado para el tipo de dehiscencia de las demás de las especies del género. Esta particularidad del fruto ocurre también en dos

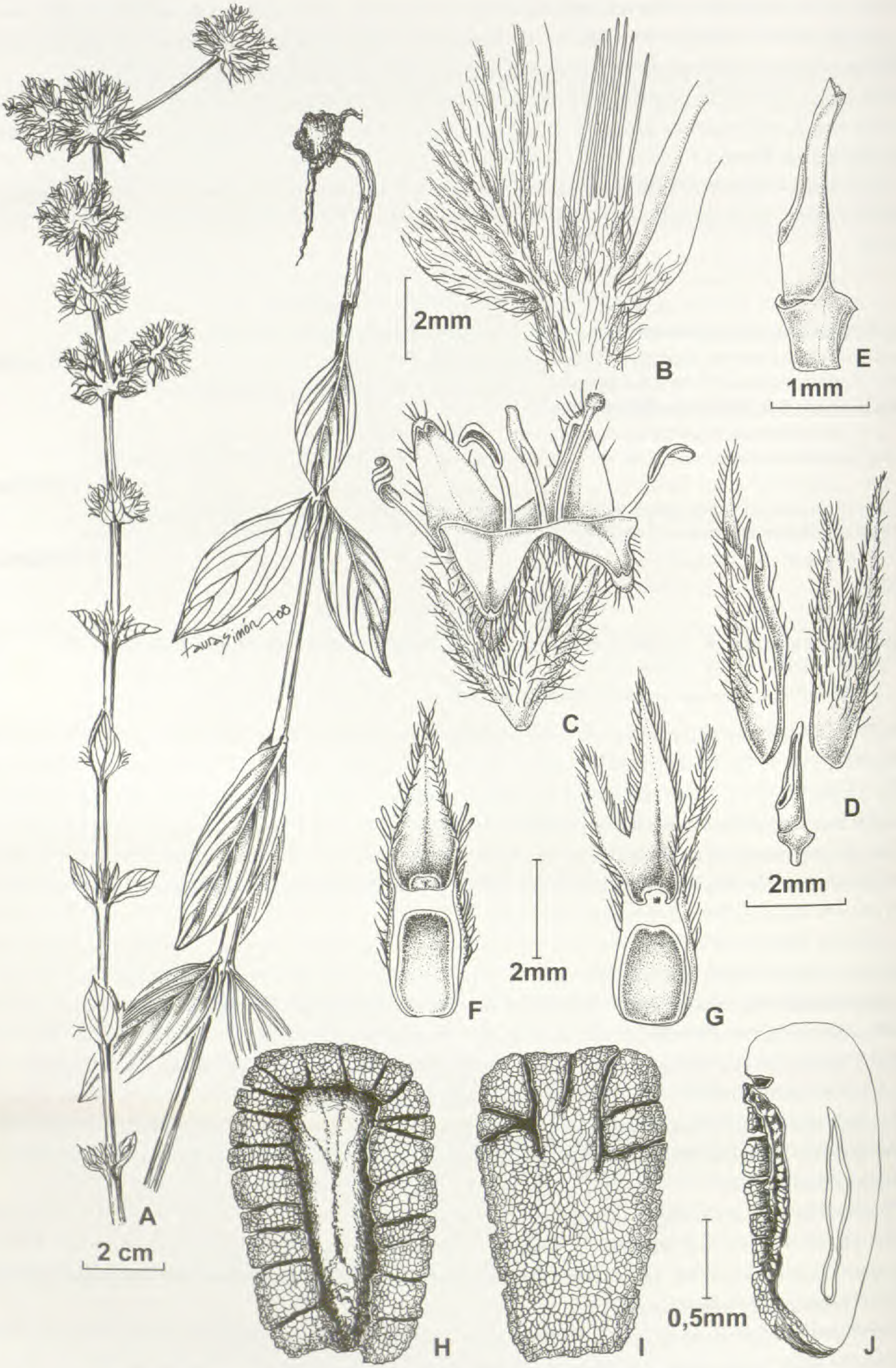
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Fig. 3. *Planaltina capitata* [*Hatschbach, G. & J.M. Silva 60036* (CTES)]. **A.** Hábito. **B.** Vaina estipular. **C.** Flor. **D.** Fruto dehiscente. **E.** Septo intercarpelar. **F, G.** Vista interna de valvas del fruto. **H.** Cara ventral de la semilla. **I.** Cara dorsal de semilla. **J.** Corte longitudinal de semilla.

especies africanas de *Spermacoce* s. lat., *S. sphaerostigma* (A. Rich.) Vatke y *S. phyteuma* Schweinf. ex Hiern. (Dessein 2003). Sin embargo, en *P. capitata* se observó que sucede cuando aún se encuentran inmaduros fruto y semillas.

Especímenes adicionales examinados: **BRASIL. Distrito Federal:** Brasília, 2 Feb 1966 (fl), *H.S. Irwin et al. 12193* (NY); Brasília, open campo near British Embassy, 18 May 1966 (fl), *D.R. Hunt 5503* (NY); Brasília, Universidade de Brasília, Campus da Colina, 26 Ago 1965 (fr), *D. Sucre 815* (UB); Brasília, Bacia do Rio São Bartolomeu, Córrego Lage, 26 Feb 1981 (fl), *E.P. Heringer et al. 6342* (IBGE); Brasília, Bacia do Rio São Bartolomeu, 30 Abr 1980 (fl), *E.P. Heringer et al. 4550* (IBGE); idém, 5 May 1980 (fl), *E.P. Heringer 4597* (NY); Brasília, morro à margem direita do Córrego Cabeça de Veado, 8 Abr 1980 (fl), *E.P. Heringer et al. 4268* (NY, IBGE); Brasília, APA gama e Cabeça de Veado, Área do Córrego do Cedro, R.A. do Núcleo Bandeirante, 15°53'46"S, 47°56'36"W, 990 m, 14 May 2003 (fl), M.L. *Fonseca & D. Alvarenga 4751* (IBGE); Brasília, APA Gama e Cabeça de Veado, R.A. do Lago do Sul, Fazenda Água Limpa (FAL-UnB), 15°55'0"S, 47°54'42,6"W, 7 May 2003 (fl), M.L. *Fonseca & D. Alvarenga 4686* (IBGE); Brasília, DF-100 a 99,7 Km do CENARGEN/EMBRAPA, 15°53'S, 47°23'W, 5 May 1992 (fl), T.A.B. *Dias et al.* 87 (CEN, NY); Brasília, DF-170 a 6 km da DF-100, 15°33'S, 48°3'W, 4 Jun 1992 (fl), *T.A.B. Dias et al. 159* (CEN); Brasília, 10 km a E do Centro Olímpico, 27 Mar 1981 (fl), C.E.M. *Franco* 15 (UB); Brasília, 10 km ao NE do Centro de Brasília, 10 May 1984 (fl), *M.C. Ferreira & L.M. Moraes 9* (NY, UB); 1° parada 9 km ao N do centro de Brasília, 24 May 1984 (fl), *M.C. Ferreira & L.M. Moraes 12* (NY, UB); 17 km em linha reta de SSE do centro de Brasília, May 1984 (fl), *R.G. Cassia 6* (NY); Parque Ecológico Norte Burle Marx, 29 Abr 2004, *J.R. Santos & G.A Moreira 209* (CEN); Brasília, 975 m, 29 Oct 1965 (fl), *H.S. Irwin et al. 9686* (UB); Brasília, em frente ao BGP, 25 Jun 1965 (fl), *E.P. Heringer 10455* (UB); Córrego Fazendinha, 15°47'S, 47°43'W, 1.000 m, 22 May 1984 (fl), *A.B. Pereira 36* (UB); km 30 da Estrada Brasília-Cocalzinho, 15°40'S, 48°20'W, 1.225 m, 14 May 1991 (fl), *R.F. Vieira & B.M.T. Walter 752* (CEN); 2 km NE do Córrego Sítio Novo, 15°33'S, 47°31'W, 1.160 m, 13 Jun 1983 (fl), *J.H. Kirkbride 5330* (UB); Parque Recreativo do Gama, 15°59'S, 48°02'W, 1.160 m, 15 Abr 1994 (fl), *M. Ianhez 23* (UB); entre o Parque do Gama e o Rio Corumbá, 12 Jul 1954 (fr), *A.P. Duarte & A. Matos 8356* (UB); Mun. Padre Bernardo, ca. 14 km da cidade, estrada para Dois Irmãos, 15°15'11"S, 48°21'18"W, 635 m, 12 Abr 2003 (fl), *M.L. Fonseca et al. 3469* (IBGE); Vargem Bonita, Faz. Água Limpa, 15°36'S, 47°55'W, 1.030 m, 10 Jun 1982 (fl), *E.M. Pereira 4* (UB); Vargem Bonita, Faz. Água Limpa, ca. 18 km SSW da torre de TV de Brasília, 8 Jun 1976 (fl), *J.A. Ratter et al. 3111* (UB); Vargem Bonita, Faz Água Limpa, ca. 18 km SSW da torre de TV de Brasília, 20 Abr 1976 (fl), *J.A. Ratter & S.G. Fonseca 2913* (UB); Faz. Água Limpa, 15°57'S, 47°56'W, 12 Feb 1980 (fl), *H.L. César 402* (UB); Faz. Água Limpa, divisa com o Cristo Redentor (Jardim Botânico de Brasilia) e o IBGE,Córrego Taquara, 15°55'45"S, 47°54'20"W, 16 May 2000 (fl), *C. Munhoz et al. 1441* (IBGE); Córrego Barrocão, 15°37'S, 48°9'W, 1.140 m, 2 May 1983 (fl), *J.H. Kirkbride 5276* (NY, UB); Brasília, Universidade de Brasília, Campus da Colina, entre a Universidade e o Lago Paranoá, 1.050 m, 11 Abr 1968 (fl), *D. Philcox & E. Onishi 4774* (NY, UB); Campus da UnB, 15°45'S, 47°51'W, 16 Nov 1977 (fl, fr), *Classe de Taxonomia da UnB 528* (UB); Reserva Ecológica IBGE, 15°56'41"S 47°53'7"W, 1.100 m, 26 May 1995, *M.A. Silva 2614* (IBGE, UB, US); Reserva Ecológica IBGE, 15°56'62"S 47°52'5"W, 25 May 1988, *N.M. Pereira 30* (IBGE, R, UB); Brasília, Córrego Jerivá, E do Lago Paranoá, 975 m, 27 Abr 1966 (fl), *H.S. Irwin et al. 15369* (NY, UB); Brasília, 3–4 km do Lago Paranoá, 15°43'S, 43°48'W, 1.170 m, 27 Ene 1972 (fl), *J.H. Kirkbride 1706* (NY, UB); Brasília, Barragem do Paranoá, 19 May 1976 (fl), *E.P. Heringer 15791* (IBGE, NY, UB); Samambaia, 15°52'S, 48°3'W, 1.150 m, s.f., *J.M. Rezende 324* (CEN); Samambaia, Parque Boca da Mata, 15°52'S, 48°3'W, 1.150 m, 31 Jul 1995 (fl, fr), *J.M. Rezende 31* (CEN, CTES); Sobradinho, 5 Feb 1975 (fl), *E.P. Heringer 14384* (UB); Sobradinho, ca. 1 km W de Sobradinho, 1.100 m, 5 Dic 1965 (fl), *H.S. Irwin et al. 11068* (UB); Fazenda Sucupira. Lado direito, antes da 1° ponte na estrada principal da fazenda, 15°55'0"S, 48°1'0"W, 9 Jun 1999 (fl), *J.G. Faria & J.B. Pereira 175* (CEN); Fazenda Sucupira, cerrado lateral com o CAPRIL, 15°55'S, 48°01'W, 1.070 m, 6 May 1999 (fl), *J.G. Faria & A.A. Santos 101* (CEN); Contagem, ca. 10 km NE de Brasília, 1.000 m, 11 Set 1965 (fl), *H.S. Irwin et al. 8206* (NY, UB); Contagem, 22 Feb 1966 (fl), *E.P. Heringer 11019* (NY, UB); Rod. Brasília-Anápolis, ca. 35 km SW de Brasília, 700–1.000 m, 6 Set 1964 (fl), *H.S. Irwin & T.R. Soderstrom 6045* (UB); Guará, Estrada Guará-Taguatinga, 3 km do Guará, 4 Abr 1980 (fl), *M.C.G. Kirkbride 1179* (UB); Brasília, lado esquerdo da estrada de Ferro Centro-Oeste, próximo ao Cantinho, 11 May 1988 (fl), M.A. *Silva et al.* 647 (IBGE, RB); Reserva Biológica de Águas Emendadas, ca. 40 km a NE de Brasília, 15°32'S, 47°37'W, 1.000–1.150 m, 9 Feb 1983 (fl), *P.E.A.M. Oliveira 180* (CEN); Reserva Biológica de Águas Emendadas, ca. 40 km a NE de Brasília, 15°32'S, 47°37'W, 1.000–1.150 m, 13 Jul 1982 (fl), A.E. *Ramos 64* (CEN); Reserva ecológica do Guara, 15°48'S, 47°58'W, 1.035 m, 19 Ene 1994, *G.P. da Silva 2193* (CEN); Parque Nacional de Brasilia, faixa de aceiro, 15°53'0"S, 47°56'0"W, 21 Ene 1991 (fl), *P.C.M. Ramos 567* (NY, UB); Planaltina, 5 Mar 1976 (fl), *E.P. Heringer 15424* (IBGE, UB); Planaltina, km 15 da BR-020, entre Sobradinho e Planaltina, 900 m, 22 Feb 1995 (fl), *J.C.S. Silva 810* (UB); Planaltina, CPAC, BR-020 km 18, 15°35'S, 47°42'W, 14 May 1979 (fl), S.M. *Sano et al.* 77 (CEN); idem, 16 Ago 1979 (fl, fr), M.C.A. *Conceição & J.C.S. Silva 69* (CEN); idem, 8 May 1979 (fl), *J.A. Silva et al. 306* (CEN); idem, 20 Oct 1988 (fr), *J.C. Silva 709* (IBGE); idem, 22 Feb 1995 (fl), *J.C.S. Silva 810* (CEN); Planaltina, Morro da Igrejinha, 1.000 m, 18 Feb 1970 (fl), *H.S. Irwin et al. 26354* (NY, UB); Planaltina, BR-020 em direção a Planaltina, 15°35'S, 47°35'W, 1.155 m, 15 Abr 2004 (fl), *E.B. Souza et al. 1183* (HUEFS), *E.B. Souza et al. 1184* (HUEFS); Planaltina, BR-020, km 15, entre Planaltina e Sobradinho, 15°37'S, 47°43'W, 1.144 m, 15 Abr 2005 (fl.), *E.B. Souza et al. 1191* (HUEFS); Mun. Brazlândia, 24 May 1985 (fl), *J.C.S. Silva 407* (IBGE); Mun. Brazlândia, DF-3, Km 17 após a segunda ponte sobre o Rio do Sal, 15°18'S, 48°10'W, 24 Abr 1996 (fl), *S.M. Gomes 37* (CEN); Palma, 15°34'S, 48°2'W, 1210 m, 30 Mar 1982 (fl), *J.H. Kirkbride 4708* (NY, UB); Palma, 15°34'S, 48°2'W, 9 Jun 1981 (fl), *A.C.S. Berçot 45* (UB); Brasília, Tororó, 24 Jun 1985 (fl), *F.M. Peres s.n.* (UB); Brasília, Barragem do Paranoá, 19 May 1976 (fl), *E.P. Heringer 15791* (IBGE, UB); Reserva Ecológica do Roncador, 15°57'S, 47°53'W, 27 Abr 1993 (fl), *B.M.T. Walter 2060* (NY, UB); REIBGE, área do Projeto Fogo, 14 May 1991 (fl), *P.S. Câmara 128* (IBGE). **Goiás:** Mun. Abadiana, GO-060, km 84, 22 May 1975 (fl), *G. Hatschbach 36692* (CTES, NY); Mun. Água Fria de Goiás, Estação Repertidora da Telebrasília de Roncador, 8 Feb 1994 (fl, fr), *G. Hatschbach & J.M. Silva 60036* (CTES); Mun. Água Fria de Goiás, Rod. GO-118, subida para a Torre Repetidora de Roncador, 8 May 2000, *G. Hatschbach et al. 70655* (CTES); Mun. Goianésia, 35 km pela rod. ao Norte de Goianésia, 15°4'S, 49°3'W, 19 Abr 1988 (fl), *J.A. Rizzo et al. 10623* (UFG); Cidade Eclética, 50 km de Brasília, 10 Mar 1974 (fl), *E.P. Heringer 13159* (UB); Serra Geral do Paraná, Mun. São João da Aliança, ca. 10 km S de São João da Aliança, 950 m, 17 Mar 1971 (fl), *H.S. Irwin et al. 32013* (NY, UB); Serra Geral do Paraná, Mun. São João da Aliança, 7 km pela rodovia S de São João da Aliança, 1.100 m, 22 Mar 1973 (fl), *W.R. Anderson 7660* (UB); Mun. Cocalzinho de Goiás, estrada de aceso à Serra dos Pirenópolis, a cerca de 8 km de Cocalzinho, 28 May 1998, *M.C. Assis et al. 551* (CEN); Mun. Corumbá de Goiás, vizinhanças de Corumbá, 20 Jun 1972 (fr), *E.P. Heringer 12147* (UB); Mun. Goiânia, estrada que se dirige ao Seminário Santa Cruz, a 1 km do córrego do açude, 16 May 1968 (fl), *J.A. Rizzo & A. Barbosa 776* (UB, UFG); Mun. Goiânia, margem esquerda da Rod. GO-7, próximo ao córrego Pindaíba, 10 Abr 1968 (fl), *J.A. Rizzo & A. Barbosa 195* (UB, UFG); Serra do Topázio, Mun. Cristalina, 20 km antes de Cristalina, 28 Jun 1973 (fl, fr), *J.A. Rizzo 9101* (UFG); Mun. Cromínia, 5 km Sw de Cromínia, 17°19'S, 49°25'W, 775 m, 13 Abr 1988 (fl), *J.A. Rizzo et al.* 10577 (UFG); Mun. Goiânia, A direita da GO-7, que liga Goiânia a Guapó, 10 km de Goiânia, 7 Ago 1968 (fl, fr), *J.A. Rizzo & A. Barbosa 1947* (UFG); Mun. Goiânia, direita da rodovia GO-7, entre Goiânia e Guapó, 10 km de Goiânia, 15 May 1968 (fl), *J.A. Rizzo & A. Barbosa* 693 (UFG); Mun. Luziânia, estrada vicinal de aceso ao Rio Descoberto, 16°17'17"S, 48°10'43"W, 900 m, 2 Jul 2003, *G.P. Silva et al. 7942* (CEN); Mun. Luziânia, Faz. do Sr. José Rodrigues, próximo à Sede, 16°19'47"S, 48°12'49"W, 920 m, 9 Abr 2003, *G.P. Silva et al. 7487* (CEN); Mun. Luziânia, 39 km em direção a Cristalina, 5 May 1993 (fl), *H.D. Ferreira 3987* (NY, UFG); Mun. Luziânia, Santo Antonio do Descoberto, 27 Mar 1980, *E.P. Heringer 17685* (IBGE); Mun. Goiás, Serra de Santa Rita, Dto. Jeroaquara, 26 Jun 1971 (fl, fr), *J.A. Rizzo & A. Barbosa 5724* (UFG); Mun. Sancrelândia, Serra da Mangabeira, 12 km de Mangabeira, 23 Mar 1984(fl), *J.A. Rizzo 10393* (UFG); Mun. Uruaçu, 8 km do Rio Maranhão, 14 Jun 1972 (fl), *J.A. Rizzo 8149* (UFG); Mun. Uruaçu, 11 May 1972 (fl), *A.J. Rizzo 8086* (UB, UFG); Mun. Uruaçu, 14 Jun 1972 (fl), *A.J. Rizzo 8149* (UB); Mun. Niquelândia, baixada ca. 20 km de Niquelândia, estrada de terra que vai para a Mina de Níquel, 14°21'27"S 48°24'20"W, 28 Abr 1995, *F.C.A. Oliveira, et al.* 342 (IBGE); Mun. Niquelândia, estrada à esquerda da mina de níquel, 14°20'S, 48°23'W, 31 May 1996 (fl), *M.L. Fonseca et al 997* (IBGE); Mun. Formosa, 20 Oct 1961 (fl), *E.P. Heringer 10715* (UB); Mun. Goiânia, margem direita da rodovia GO-4, 8 Ago 1968 (fl), *A.J. Rizzo & A Barbosa* 1970 (UB, UFG); Mun. Alto Paraíso, Chapada dos Veadeiros, ca. 6 km E de Alto Paraíso, 14°S, 47°W, 1.500–1.600 m, 23 Ene 1979 (fl, fr), *S.S. Silva 13* (UB); Mun. Cristalina, rodovia BR-040, 2 km E de Cristalina, 1.100 m, 13 Ago 1980 (fl), *G. Hastchbach 43069* (UB); Mun. Santo Antônio do Descoberto, 27 Mar 1980 (fl), *R.C. Mendonça 91* (UB).

2. Planaltina lanigera (DC.) R.M. Salas & E.L. Cabral, comb. nov. (**Figs. 2, R–T, X, 4**). *Tessiera lanigera* DC. Prodr. 4:574. 1830. *Spermacoce lanigera* Bart. ex DC. 4:574. 1830. nom. nud. Tipo: BRASIL. Distrito Federal: "Brasília, prope Maria da Souza," *J.E. Pohl 5085* (holotipo: G-DC n.v.; isotipo: W).

Sufrútice de 60–100 cm alt., erecto; tallos subcilíndricos glabros en la base, a veces decorticados, apicalmente lanosos blanquecinos. Vaina estipular 2,5–3,5 mm, lanosas, raro glabra, con 7–10 lacinias de 2–7 mm, ciliadas. Hojas 18–31 × 7–13 mm, opuestas, sésiles, láminas ovadas, ápice agudo, base cordada, coriáceas, discoloras, con 2–3 pares de nervios, plegado-nervosas, haz verde-grisácea, lanosa o glabra, envés blanco-lanoso. Inflorescencias subesféricas, 9–14 mm lat., apicales y axilares, 18–22 (–30) glomérulos por rama florífera, 2 brácteas foliáceas, patentes, ovadas. Flores pediceladas, pedicelo 0,3–0,5 mm. Hipanto con la mitad superior lanoso. Cáliz 5–6-lubulado, lóbulos 1–1,5 mm, triangulares, desiguales, 2 mayores y 3–4 menores, densamente lanosos. Corola 4–5 mm, blanca; lóbulos 2 mm, triangulares, externamente pubérulos. Estambres exertos, de igual tamaño que los lóbulos corolinos; filamentos 1–1,5 mm; anteras de 1–1,2 mm long. Estilo 4,5–5 mm; estigma capitado-bilobado. Cápsula 2,5–3 mm, obovoide mitad superior lanosa; valvas coronadas por los lóbulos del cáliz en división 3–2 ó 3–3. Semilla 1,5–1,8 ×1 mm, obovoide, nigrescentes, superficie dorsal convexa, lustrosa, cara ventral surcada, márgenes con 2–3 surcos estrechos, cubierta seminal retículo-areolada o foveada.

Distribución, hábitat y ecología.—Especie con distribución geográfica restringida a los estados de Goiás y Minas Gerais. Existen escasas colecciones de *Planaltina lanigera* en los herbarios consultados de Brasil, las observaciones de campo de las etiquetas la mencionan exclusivamente para el bioma Cerrado, viviendo aparentemente en pequeñas poblaciones. De acuerdo a Salas & Souza (en prensa) es una especie vulnerable a extinción, debido principalmente a su limitada distribución y a escasas colecciones, todas fuera de áreas protegidas. Delprete & Cortés (2006), citan a esta especie, bajo *Staelia lanigera*, en un listado preliminar de especies de Mato Grosso y Mato Grosso do Sul, sin hacer mención de un ejemplar que lo atestigüe, en este trabajo no se pudo confirmar su presencia para estos dos estados.

Planaltina lanigera es comúnmente confundida con *P. capitata*, pero a esta última especie se la puede diferenciar por tener 2–4(–10) glomérulos por rama florífera, con 2–4 brácteas elípticas, por corola de menor tamaño y semillas con márgenes ruminados.

D
2cm
C
B
3mm
G
0,5mm
2cm
F
2mm
A
E
2mm

Fig. 4. *Planaltina lanigera* [*Hatschbach, M. et al. 64238* (CTES)]. **A.** Hábito. **B.** Vaina estipular. **C.** Flor. **D.** Interior de corola desplegada, estilo y estigma. **E–F.** Fruto dehiscente. **E.** Valvas caducas. **F.** Septo intercarpelar y vista lateral de valvas. **G.** Cara ventral de semilla.

Especímenes adicionales examinados: **BRASIL. Goiás:** Chapada dos Veadeiros, 37 km N de Veadeiros, 1.000 m, 14 Mar 1969 (est.), *H.S. Irwin et al. 24373* (NY, UB); Sul de Jeroaquara, 24 Abr 1971 (fl, fr), *J. A. Rizzo & A. Barbosa 5507* (UB). **Minas Gerais:** Serra do Cabral, Mun. Joaquim Felício, ao este de Joaquim Felício, 1.000 m, 6 Mar 1970 (fl, fr), *H.S. Irwin et al. 27011* (NY, UB); Serra do Cabral, 3 km W de Cantoni, 1.000 m, 9 Mar 1970 (fl, fr), *H.S. Irwin et al. 27223* (NY, UB); Serra do Cabral, Mun. Joaquim Felício, 17 Jan 1996 (fl, fr), *G. Hatschbach et al. 64238* (CTES, NY).

3. Planaltina myndeliana R.M. Salas & E.L. Cabral, sp. nov. (**Figs. 2, Y–Z, 5**). Tipo: BRASIL. Goiás: Mun. São João da Aliança, Córrego das Brancas, próximo a barra do Jacaré, 9 Feb 1994 (fl, fr), *G. Hatschbach & J.M. Silva 60266* (holotipo: MBM; isotipo: CTES).

Affinis *P. lanigera* et *P. capitata*, sed ab *P. lanigera*, a quo imprimis foliis ovatis lanuginosis versus ellipticis vel anguste ellipticis hispidis, calycis segmentis 1–1,5 mm longis versus segmentis 4–6 mm longis, corollis 7–7,5 longis versus corollis 4–5 mm longis, glomeruli floralis 18–22 (–30) in ramis floriferis versus glomeruli floralis 2–4 in ramis floriferis differt. Ab *P. capitata* calicys segmentis, lanuginosis versus hispidis, 4–partitis versus 5–7-partitis differt.

Sufrútice de 30–40 cm alt., erecto, tallos subcilíndricos, pubérulos, vellosos o híspidos. Vaina estipular 0,8–1 mm, pilosa, con 4–5 lacinias de 6–7 mm, ciliadas. Hojas 22–50 × 10–12 mm, sésiles, elípticas, angostamente elípticas o elíptico-lanceoladas, ápice agudo, mucronado, base atenuada, coriáceas, híspidas plegado-nervosas, con 4–6 pares de nervios subopuestos. Inflorescencias subesféricas, 5–15 mm lat., apicales y axilares, 2–4 glomérulos por rama florífera, 2 brácteas foliáceas, patentes, elípticas o angostamente elípticas. Flores subsésiles. Hipanto pubescente. Cáliz 5–7-lobulado, lóbulos 4–6 mm, triangulares, desiguales, híspidos. Corola 7–7,5 mm, blanca; lóbulos triangulares, externamente pubescentes. Estambres exertos, de igual tamaño que los lóbulos corolinos; filamentos 1,5–1,6 mm; anteras 1,4–1, 5 mm. Estilo 7–8 mm; estigma capitado-bilobado. Cápsula 4,3–4,8 × 3,8–4,2 mm, obovoide, pubescente; valvas coronadas por los lóbulos del cáliz en división 3–2, 3–3 ó 3–4. Semilla inmadura.

Etimología.—Esta especie está dedicada al botánico danés Myndel Pedersen, por sus aportes al conocimiento de la flora americana y sobre todo por gratitud, porque a través de su fundación ha contribuido con taxónomos sudamericanos en la concreción de viajes de colección y de consulta de herbarios europeos y americanos.

Distribución, hábitat y ecología.—Conocida solamente por dos colecciones del Estado de Goiás, una del municipio de São João da Aliança y la otra a aproximadamente 50 km de distancia en el Parque Nacional Chapada dos Veadeiros. De acuerdo a los ejemplares estudiados habita solamente en el bioma Cerrado. Florece y fructifica de diciembre a febrero.

Planaltina myndeliana es morfológicamente similar a *P. lanigera* y *P. capitata*. Con respecto a *P. lanigera*, difiere en la forma e indumento de las hojas, ovadas lanuginosas versus elípticas o angostamente elípticas, hispidas, en el tamaño de los lóbulos del cáliz, 1–1,5 mm versus 4–6 mm long., en el tamaño de la corola 7–7,5 mm versus 4–5 mm long., en el número de glomérulos por rama florífera, 18–22 (–30) en *P. lanigera* versus 2–4 glomérulos en *P. myndeliana*. Mientras que de *P. capitata*, se diferencia en el indumento y número de lóbulos del cáliz, lanuginosos versus híspidos, 4-lobulado versus 5–7-lobulado.

Especímenes adicionales examinados: Brasil, Goiás, Chapada dos Veadeiros, 21 Dic 1967, *A.P. Duarte 10670* (HB n.v., UB).

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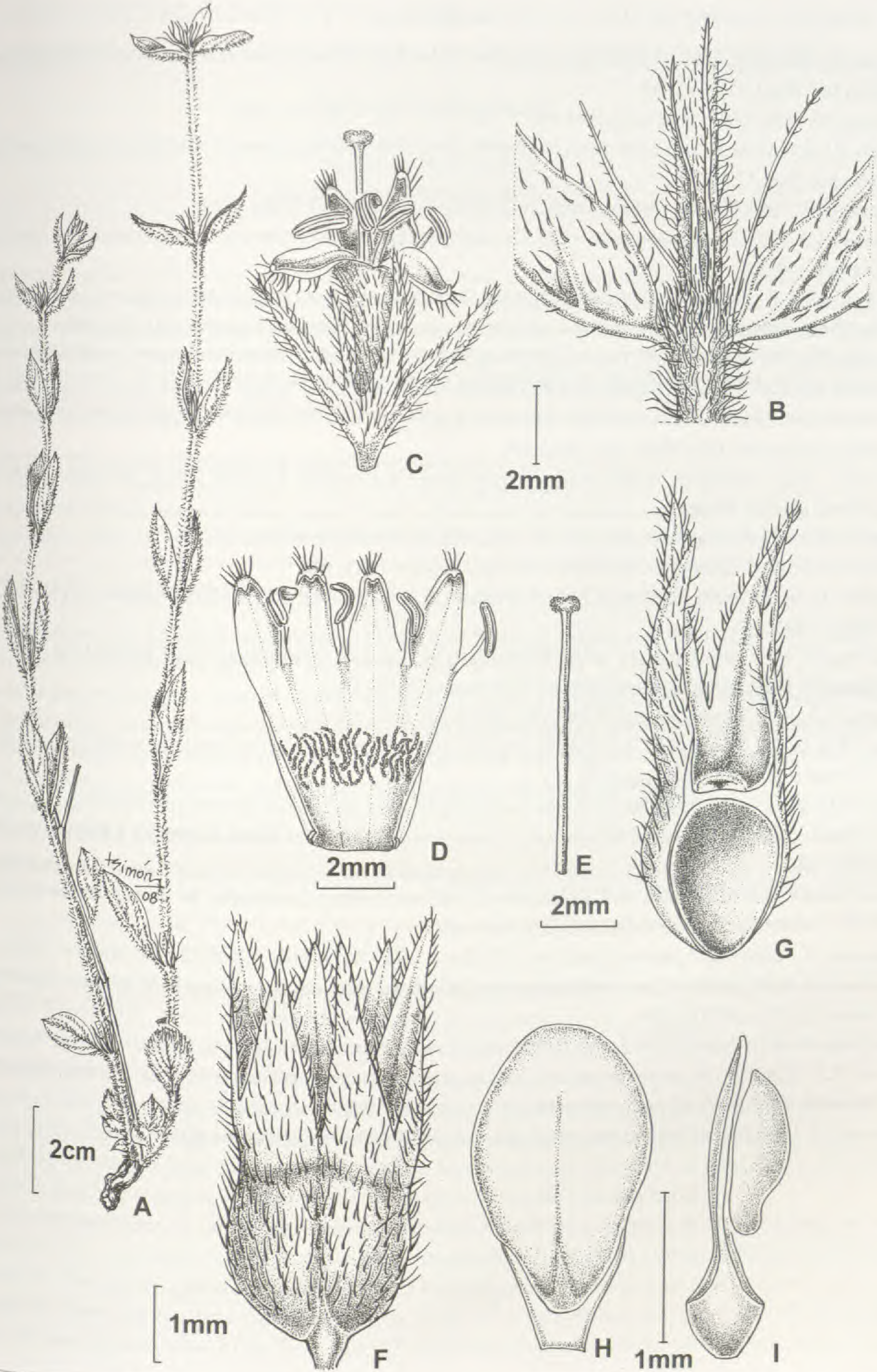
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Fig. 5. *Planaltina myndeliana* [Holotipo, *Hatschbach, G. & J.M. Silva* 60266 (CTES)]. A. Hábito. B. Vaina estipular. C. Flor. D. Interior de corola desplegada. E. Estilo y estigma. F. Fruto inmaduro. G. Vista interna de valva. H. Vista interna del septo intercarpelar. I. Septo intercarpelar y semilla inmadura.

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A NEW VARIETAL COMBINATION, TYPIFICATION, AND NOMENCLATURAL COMMENTS IN THE NYCTAGINACEAE FOR THE INTERMOUNTAIN FLORA

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ABSTRACT

Miscellaneous comments regarding nomenclature and typification are made for the Nyctaginaceae of the Intermountain region of the western United States. **Tripterocalyx carneus** (Greene) Galloway var. **pedunculatus** (M.E. Jones) Spellenb. is presented as a new combination. *Abronia crux-maltae* Kellogg is neotypified. *Boerhavia spicata* Choisy var. *torreyana* S. Wats. and *Oxybpahus glaber* S. Wats. are lectotypified. The inadvertent lectotypfications by past workers of *Abronia bakeri* Greene, *Ab. robusta* Standl., *Allionia glandulifera* A. Nels., and *Al. incarnata* L. var. *glabra* Choisy in DC. are discussed. The widespread and variable *Allionia incarnata* L. needs a neotype.

RESUMEN

Se hacen varias observaciones con respecto a la nomenclatura y tipificación de las Nyctaginaceae de la región intermontana del oeste de los Estados Unidos. **Tripterocalyx carneus** (Greene) Galloway var. **pedunculatus** (M.E. Jones) Spellenb. Se presenta como una combinación nueva. *Abronia crux-maltae* Kellogg que se neotipifica. Se lectotipifican *Boerhavia spicata* Choisy var. *torreyana* S. Wats. y *Oxybpahus glaber* S. Wats.. Las lectotipficaciones inadvertidas por taxónomos en tratamientos taxonómicos anteriores de *Abronia bakeri* Greene, *Ab. robusta* Standl., *Allionia glandulifera* A. Nels., y *Al. incarnata* L. var. *glabra* Choisy in DC. se discuten. *Allionia incarnata* L. muy difundida y variable, necesita un neotipo.

The final volume, vol. 2A, of the Intermountain Flora now largely in preparation by Noel and Pat Holmgren of the New York Botanical Garden will have a treatment by me for the Nyctaginaceae for the region. This area encompasses all of Utah, most of Nevada, and parts of some of the adjacent states. In the course of preparing that work, I have here selected neo- or lectotypes for some names that mostly apply to plants within the Intermountain region, have provided one new nomenculatural combination, and included some notes on other problems in typification, particularly noting inadvertent lectotypifications.

A NEW VARIETAL COMBINATION

Tripterocalyx carneus (Greene) Galloway var. **pedunculatus** (M.E. Jones) Spellenb., comb. nov. *Tripterocalyx micranthus* (Torr.) Hook. var. *pedunculatus* M.E. Jones. Proc. Calif. Acad. Sci. ser. 2, 5:716. 1895. Type: UTAH. Washington Co.: St. George, 2700 ft, 26 Apr 1894, *M.E. Jones 5101* (lectotype: US!, inadvertently lectotypified in Galloway, Brittonia 27:335. 1976 ("1975"). His date 1844 [for 1894] is a typographical error.).

Mayr (1969) warned of using low weight regressive characters to define taxa. Such apparently has happened in *Tripterocalyx*, where the reduced, whitish green perianth (7–18 mm) has been largely used to define *Tripterocalyx micranthus* (Torr.) Hook. *sensu lato* relative to other taxa in the genus, particularly *T. carneus* (perianth [18–]25–29 mm). The reduction of size and coloration in the perianth likely has been in response to increased autogamy. Douglas (2008) showed that at least one population of the large-flowered *T. carneus*, well to the south of the small-flowered forms, is self-compatible and probably capable of autogamy. Throughout the range of large-flowered *T. carneus* are occasional small-flowered variants. Thus, reduction of perianth length in response to vagaries in pollination may be easily accomplished.

As interpreted here, in the northern part of its range *Tripterocalyx carneus* enters into a more or less abrupt reduction in perianth length. More northern populations have shorter flowers relative to southern populations. This occurs primarily in northeastern Arizona, southern Utah, and southwestern Colorado through the phase that has been called *T. wootonii* Standl. as delimited by Galloway (2003). Even farther north, the small flowered plants have been called *T. micranthus* (Galloway 2003). Early on M.E. Jones noted

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these plants to be different, distinguishing them as the *T. micranthus* var. *pedunculatus* M.E. Jones. In fruit these northern plants are indistinguishable or distinguished only with difficulty from *T. carneus* to the south, but are readily distinguishable from *T. micranthus* (*sensu stricto*), which occurs to the east, as follows:

1. Fruit body papery-spongy (can be easily scraped and broken with a needle), the spongy tissue ± obscuring the ribs **T. micranthus**
2. Fruit body indurate (not easily damaged by scraping with needle), ribs prominent **T. carneus** var. **pedunculatus**

The two deceptively similar taxa have nearly separate geographic ranges. *Tripterocalyx micranthus* is a taxon primarily of the western Great Plains, barely reaching northeastern and central-eastern Utah. *Tripterocalyx carneus* var. *pedunculatus* is a taxon of the arid Intermountain Region, from sw. and wc. Utah to eastern Utah, sw. Colorado, and ne. Arizona. The two are closely adjacent or sympatric in Uintah and Grand cos., Utah.

NEOTYPES AND LECTOTYPES

Abronia crux-maltae Kellogg, Proc. Calif. Acad. Sci. 2:71, fig. 16. 1863. Type: NEVADA. Ormsby Co.: Eagle Valley, 0.2 road mi N of highway 50 on Centennial Drive then NE 0.1 mi along a pole line road, T15N, R20E, S2. 4700 ft, 39°11'45.7"N, 119°41'46.4"W, WGS-1984, growing with *Tetradymia canescens* on sand flats, flowers pink to white, 19 May 2008, *Arnold Tiehm 15520* (neotype, here designated: CAS; isoneotypes: ARIZ, ASC, B, BRIT, BRY, C, COLO, G, GH, ID, K, LE, NMC, MEXU, MO, MONTU, MT, NY, OSC, P, RENO, RM, RSA, TEX, UC, UNLV, UNM, US, UT, UTC, WTU, Z).

In 1863 Kellogg described a novel Nyctaginaceae brought to him from the Carson Valley, Nevada, by A. A. Veatch. He named the plant *Abronia crux-maltae* [now generally recognized as *Tripterocalyx crux-maltae* (Kellogg) Standl.] because the shape of perianth limb was reminiscent of a Maltese cross. He provided a thorough written description, contrasting the new species with *A. cycloptera* A. Gray (*nom. nud.*), noting the 4-merous perianth, but he included an erroneous illustration (fig. 16) that might be several other *Tripterocalyx* or *Abronia*, but which is incorrect for *T. crux-maltae*. This is a fairly crude line drawing of a stem with a flowering head bearing flowers with a 5-merous (or slightly greater) perianths blooming synchronously, as in *Abronia*. None of the perianths is drawn as 4-lobed, a characteristic of *T. crux-maltae*. The most distinctive feature of *T. crux-maltae*, the fruit, is not illustrated. He cited no specimen at the time, and one has not been found at CAS or elsewhere. Galloway (1975) observed "no type cited," and Tiehm (1996) stated "collector not named [type not extant]." Curran (1885) cited the name but listed no type; from other examples from this publication it is apparent that Kellogg might not have always made specimens or, if he did so, sometimes didn't keep them. If a type specimen ever did exist, it may have been destroyed in the 1906 San Francisco fire.

A neotype is here selected from a fine and ample collection made specifically for this purpose from the general vicinity of the Carson Valley.

Boerhavia spicata Choisy var. **torreyana** S. Watson, Proc. Amer. Acad. Arts 24:70. 1889. Type: TEXAS. Presidio Co.: prairie near Marfa, W. Texas, Sep 1883, *Havard 61* (lectotype, here designated: GH-HUH barcode 37323).

Notes.—This specimen was seen by Watson with sketches of the flower on the sheet. It has twice been anonymously annotated as "type." The taxon is now recognized at the species level by Spellenberg (2003) as proposed by Standley (1909, 1911, 1918).

Watson (1998) was discussing variation in *Boerhavia spicata* Choisy, within which he coined names for two varieties, *B. spicata* var. *palmeri* S. Wats. and *B. spicata* var. *torreyana*. Contrasting plants from the Southwest, Watson wrote (p. 70), "The form of Texas, New Mexico, and Arizona that has been referred to this species is usually more glandular than the var. *Palmeri*, the leaves thickish and scabrous, and the perianth about a line long. It may be distinguished as var. (?) *Torreyana*." These taxa have been discussed in Spellenberg (2002). Watson cited a type for the var. *palmeri*, but he did not for var. *torreyana*. In 1909 Standley raised the taxon to species level as *B. torreyana* (S. Wats.) Standl., noting that no type was cited. He also did not cite a type in later publications (1911, 1918). Reed (1969), who was consistent about citing types at least at US, treated the taxon as a synonym of *B. spicata*, and also cited no type.

Oxybaphus glaber S. Watson, Amer. Naturalist 7:302. 1873. Type: UTAH: Kanab, S Utah, "dry soil" [protologue], 1872, *Mrs. Thompson s.n.* (lectotype, here designated: US-22574).

Notes.—Two specimens at US, apparently prepared consecutively, are each dated differently, one 1872 (US 22754), the other 1873 (US 22573). Reed (1969) cited both the US specimens as "Type." In 1993 Turner annotated US 22753 as the holotype of "*Allionia glabra* S. Wats," the name actually *A. glabra* (S. Wats.) Kuntz, a later synonym. He never published this selection of a type (Turner, pers. com. 2009). As judged by phenology and habit, and the nature of the collection method, the two US specimens appear to be from the same gathering, the "1873" date an error in transcription on the label of the US 25573 specimen. To reduce confusion resulting from varying dates, I select US 22574, "*Mrs. Thompson*, 1872, S. Utah," as the lectotype.

At GH there is a specimen with data written in Watson's hand directly on the sheet as "*Qxybaphus glaber*, n. sp., Kanab – s. Utah, Mrs. A.[sic] P. Thompson [no date], which also appears to be from the same gathering. This is a probable isolectotype. An isolectotype is at NY!, and the 1873 specimen at US is considered a probable isolectotype.

When Watson was nearing the end of his tenure at US he described *O. glaber*, citing only the type collection, without date, and no specific holotype. Watson (1873), in the introduction to a series of new names, indicated the collections of Mrs. E.P. Thompson were made in the second summer of 1871–1872.

COMMENTS ON INADVERTENT LECTOTYPES

Occasionally authors cited specimens in taxonomic treatments that resulted in inadvertent lectotypification under current international rules of nomenclature. Those that I have encountered while working with the Intermountain Nyctaginaceae are reviewed here.

Abronia bakeri Greene (Pl. Baker. 3:32. 1901). Greene proposed the name *Abronia bakeri* for a sand verbena from western Colorado. In the description he cited three syntypes, *Baker 13* from Montrose, *Baker 89* from Deer Run, and *Baker 92* from Grand Junction. He indicated no preference as to which might be a holotype in the publication or on the specimens at NDG. Galloway (1975, p. 343) placed *A. bakeri* in synonymy in *A. elliptica* A. Nelson (a disposition with which I concur), writing, "Type: Colorado. Grand Junction, 1,400 m, 11 Jun 1901, *C. F. Baker 92* (MO 1746238!), inadvertently lectotypifying the name. Barbara Hellenthal (NDG) kindly examined the *Abronia bakeri* syntypes, and noted that the labels are written out in Greene's hand; the labels of distributed specimens are in the hand of someone else. The specimens seen by Greene also have habitat information, whereas the distributed specimens do not. The NGD 15722! *Baker 92* has added information, "borders of mesas," and is an isolectotype.

Abronia robusta Standley (Contr. U.S. Natl. Herb. 12:324, plate 42. 1909). Beginning only a short time after its description, *A. robusta* has been considered a synonym of *A. fragrans* Nutt. (e.g., Standley 1918). In 1909 Standley, in commenting on his new species, wrote, "The type material in the herbarium of the Missouri Botanical garden consists of 4 sheets collected on sand hills near Monahans, Ward County, Texas, May 10, 1901, by H. Eggert." Eggert's collections were without collection number. Galloway (1975) cited MO 1746889 as the type, thereby lectotypifying the name (p. 345). James Solomon kindly checked the MO collection, and noted that MO 1746889, 1746890, 1746891 were all seen by Standley, these representing the lectotype and two isolectotypes. The fourth specimen alluded to by Standley is apparently a record-keeping error. Two other specimens at MO were annotated by him; an Eggert collection from near Colorado, Mitchell Co., Texas, 5 June 1900 (MO 1746888), and an Eggert specimen (annotated by Standley as *A. robusta* ?) from "Canadian, Texas," 7 June 1901. Neither of these last two specimens, though of some historical curiosity, should be considered in typification of the name.

Allionia glandulifera A. Nelson (Bot. Gaz. 34: 364. 1902). Nelson (1902) described this species, gave a general range, and cited no specimens. Reed (1969) consistently cited US specimens as "type" when they were part of a type gathering, inadvertently lectotypifying many names that he placed in synonymy, as he did for this name (page 173), the "Type from sunny canyon, Head of Woods Creek, Albany Co., Wyoming, Aug. 10, 1900, *A. Nelson 8048* (US-434056)." Isolectotypes are also at MO!, NY!, RM! The name is considered a synonym of *Mirabilis linearis* (Pursh) Heimerl var. *decipiens* (Standl.) Welsh.

Allionia incarnata L. var. **glabra** Choisy (in DC., Prodr. 13(2):435. 1849). This name is supported by two collections, "Circa Mexicum et ad S.-Fernando (Berlandier! Pl. mexic. exsicc. n. 577 et 2236)." Later Standley (1909) raised this to species level as *Wedelia glabra* (Choisy) Standl., transferring that name in 1930 to

Allionia glabra (Choisy) Standl., thereby creating a later homonym of *Allionia glabra* (S. Wats.) Kuntze. He immediately corrected this error, coining the name *A. choisyi* Standl. in 1931. This name has been applied to the taxon in the United States since that time.

In 1909 Standley inadvertently lectotypified *A. incarnata* var. *glabra*. In this discussion of the species he wrote (p. 332), "The description is based upon plants collected in the Mesilla Valley, New Mexico, which seem well to match portion of the type collection preserved in the Bernhardi Herbarium." Below he wrote under specimens examined, "MEXICO: Environs de Mexico (City), Berlandier, type collection; ..." He does not mention the San Fernando Collection. In the preface to his treatment (p. 304) he notes that he had the privilege of examining specimens from a number of major herbaria, among them "Missouri Botanical Garden, including the Engelmann and Bernhardi herbaria; ..." At MO is a specimen, #577, from the Bernhardi herbarium which Standley saw, annotated by him as "cotype," which by his explanation and citation in 1909 becomes a lectotype. In 1918 (p. 201) he further supports this selection of this specimen by noting the type locality of the species is "Near the City of Mexico, Mexico."

Turner (1994) lectotypified the species on Mexico, Tamaulipas, San Fernando, w/o date, *Berlandier 816* (pl. exs. *2236*), selecting G-DC as the lectotype, which he apparently did not see, and GH as an isolectotype, which he saw. Turner's lectotypification appears unnecessary.

NEED FOR A NEOTYPE

Allionia incarnata L. (Syst. Nat., ed. 10. 2: 890. 1759) needs a type. No type was specified for this name. Turner (1994) lectotypified *Allionia incarnata* by citing for the holotype *Loefling s.n.*, Sucre: near Cumana, Venezuela (LINN). Through communication with C. Jarvis (BM), who is involved with the Linnean typification project (http://www.nhm.ac.uk/research-curation/research/projects/linnaean-typification/), I learned that no such specimen exists. Loefling's material has apparently been lost. Thus, *Allionia incarnata* needs a neotype. Turner's map of the distributions of *A. incarnata* and *A. choisyi* Standl. in South America shows a lone station for *A. incarnata* near Cumana, and no other *Allionia* nearby except for a single locality for *A. choisyi* in Haiti. Both species are common in North America, plants resembling *A. choisyi* are found in the Carribean region, including the northern coast of South America, and both species are again common from southern Peru and Bolivia southward.

North American herbaria that I have surveyed have insufficient material to select a representative neotype that is part of a widespread collection. I have no information from South American herbaria. From material that I have seen, all specimens from Venezuela (which are from the coastal region) would better fit the North American concept of *Allionia choisyi*. These plants have relatively low-convex fruits with several long, slender, and comparatively thin teeth. This also applies for all specimens I have seen from the Caribbean islands. The concept of widespread and variable *A. incarnata* as understood in North America may depend on a careful collecting effort around Cumana, Venezuela, in an effort that would attempt to determine the variation occurring at the type locality prior to the selection of a neotype.

ACKNOWLEDGMENTS

I thank the following for help and advice with various nomenclatural and typification problems. Kanchi Gandhi provided advice in numerous instances, as did John Strother and Noel Holmgren. James Solomon, Ron Hartman, Barbara Hellenthal, and C. Jarvis checked for critical specimens at MO, RM, NDG, and L respectively. Pat Holmgren provided critical literature from NY. I have attempted to follow the capable guidance of these individuals; nevertheless any errors remain mine.

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BOOK REVIEW

Jonathan Silvertown. 2009. **An Orchard Invisible: A Natural History of Seeds.** (ISBN: 978-0-226-75773-5, hbk.). The University of Chicago Press, 1427 East 60th Street, Chicago, Illinois 60637, U.S.A. (**Orders:** www.press.uchicago.edu, 1-773-702-7000, 1-773-702-9756 fax). $25.00, 224 pp., 21 halftones, 5½" × 8½".

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7. The Biggest Coconut I Ever See: Size
8. Then Thousand Acorns: Number
9. Luscious Clusters of the Vine: Fruit
10. Winged Seeds: Dispersal
11. Circumstance Unknown: Fate
12. Fierce Energy: Germination
13. Sorrow's Mysteries: Poisons
14. Ah, Sun-flower!: Oil
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Silvertown has written a wonderfully entertaining, easy-to-read history of seeds that examines evolution, pollination, genetics, seed dispersal, defense mechanisms, and economic uses of seeds. Silvertown does a wonderful job of encompassing such a wide range of topics regarding seeds through beautifully written stories.

A Natural History of Seeds is a must read for anyone with an interest in ethnobotany, plants, evolution, or even anthropology. There is something in this book for everyone!—*Rebecca Swadek, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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NEW NAMES AND COMBINATIONS IN THE FLORA OF COLORADO. XIII

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The following nomenclatural changes are proposed for the fourth edition of the two volume field guide, *Colorado Flora, Eastern and Western Slope* (2010).

BORAGINACEAE

Oreocarya revealii W.A. Weber & R.C. Wittmann, nom. nov. *Cryptantha gypsophila* Reveal & C.R. Broome, Brittonia 58:178. 2006, non *Oreocarya gypsophila* Payson (1915).

Etymology.—Named in honor of James L. Reveal.

CARYOPHYLLACEAE

Gastrolychnis hitchguirei (Bocquet) W.A. Weber & R.C. Wittmann, comb. nov. *Silene hitchguirei* Bocquet, Candollea 22:29. 1967.

LOASACEAE

Nuttallia rhizomata (Reveal) W.A. Weber & R.C. Wittmann, comb. nov. *Mentzelia rhizomata* Reveal, Syst. Bot. 27:763–767. 2002.

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BOOK NOTICE

Douglas J. Futuyma, H. Bradley Shaffer, and Daniel Simberloff (eds). 2009. **Annual Review of Ecology, Evolution, and Systematics.** (ISSN 1543-592X; ISBN 978-0-8243-1440-8, hbk.). Annual Reviews, Inc., 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, U.S.A. (**Orders:** www.AnnualReviews.org, science@annualreviews.org, 800-523-8635, 650-493-4400). $84.00 indiv., 731 pp., 7 5/8" × 9 3/8".

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13. Evolution of Placentas in the Fish Family Poeciliidae: An Empirical Study of Macroevolution—*B.J.A. Pollux, M.N. Pires, A.I. Banet, D.N. Reznick*
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15. Latex: A Model for Understanding Mechanisms, Ecology, and Evolution of Plant Defense Against Herbivory—*Anurag A. Agrawal, Kotaro Konno*
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21. Woody Plant Diversity, Evolution, and Ecology in the Tropics: Perspectives from Seasonally Dry Tropical Forests—*R. Toby Pennington, Matt Lavin, Ary Oliveira-Filho*
22. Comparative Genomics on the Drosophila Phylogenetic Tree—*Nadia D. Singh, Amanda M. Larracuente, Timothy B. Sackton, Andrew G. Clark*
23. Genetic Consequences of Range Expansions—*Laurent Excoffier, Matthieu Foll, Rémy J. Petit*
24. Stoichiometrically Explicit Food Webs: Feedbacks between Resource Supply, Elemental Constraints, and Species Diversity—*Spencer R. Hall*
25. Changing Ecology of Tropical Forests: Evidence and Drivers—*Simon L. Lewis, Jon Lloyd, Stephen Sitch, Edward T.A. Mitchard, William F. Laurance*
26. Systematic and Biogeographical Patterns in the Reproductive Biology of Scleractinian Corals—*Andrew H. Baird, James R. Guest, Bette L. Willis*
27. Effects of Natural Enemy Biodiversity on the Suppression of Arthropod Herbivores in Terrestrial Ecosystems—*Deborah K. Letourneau, Julie A. Jedlicka, Sara G. Bothwell, Carlo R. Moreno*
28. Statistical Phylogeography—*L. Lacey Knowles*
29. The Nitrogen Paradox in Tropical Forest Ecosystems—*Lars O. Hedin, E.N. Jack Brookshire, Duncan N.L. Menge, Alexander R. Barron*
30. The Role of Animal Pollination in Plant Speciation: Integrating Ecology, Geography, and Genetics—*Kathleen M. Kay, Risa D. Sargent*
31. Rates of Evolution—*Philip D. Gingerich*
32. Species Distribution Models: Ecological Explanation and Prediction Across Space and Time—*Jane Elith, John R. Leathwick*
33. Mycorrhizal Symbioses and Plant Invasions—*Anne Pringle, James D. Bever, Monique Gardes, Jeri L. Parrent, Matthias C. Rillig, John N. Klironomos*

VALIDATION OF *EXOCHORDEAE* (ROSACEAE)

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ABSTRACT

Exochordeae (Rosaceae) is validly published. The name has been in use since 1964 when established by Schulze-Mentz.

RESUMEN

Se publica válidamente **Exochordeae** (Rosaceae). El nombre se ha usado desde 1964 cuando se estableció por Schulze-Mentz.

The name *Exochordeae* (Rosaceae) was proposed by Schulze-Mentz in *Syllabus der Pflanzenfamilien* (1964) without a description in Latin and thus it was not validly published. An earlier name existed for the three genera now assigned to *Exochordeae*, (*Exochorda* Lindl., *Lindleya* Kunth, *nom. cons.*, and *Oemleria* Rchb.) but that name, *Osmaronieae* Rydb., was based on *Osmaronia* Greene, a superfluous substitute for *Oemleria*, and thus the Rydberg name, like Greene's generic name, is not legitimate.

Exochordeae Schulze-Mentz ex Reveal, trib. nov. Basionym: based on a validly published but not legitimate *Osmaronieae* Rydb. in N. Amer. Fl. 22:240. 12 Jun 1918, associated with a diagnosis in English.—Type genus: *Exochorda* Lindl. (1858).—Rosaceae.

ACKNOWLEDGMENTS

I am grateful to Luc Brouillet of the Université de Montréal for his comments and to Barney Lipscomb for his patience on this minor note.

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BOOK REVIEW

Glenn Keator. 2009. **California Plant Families: West of the Sierran Crest and Deserts.** (ISBN: 978-0-520-23709-4, hbk.). University of California Press, 2120 Berkeley Way, Berkeley, California 94704-1012, U.S.A. (**Orders:** www.ucpress.edu or California-Princeton Fulfillment Services, 1445 Lower Ferry Road, Ewing, New Jersey 08618, U.S.A., orders@cpfsinc.com, 1-800-777-4726). $27.50, 224 pp., b/w line drawings, 7" × 10".

California Plant Families by Glenn Keator gives a comprehensive overview of common and important plant families seen in the greater part of California west of the Sierran Crest and Deserts. The text is laid out in an easy to use format. The beginning of the book contains a section describing the background of the book, what regions it covers, and an explanation of how to use the text. There is also a key to families followed by descriptions of the families.

For each family covered, there is a heading or discussion for: Recognition at a Glance, Vegetative Features, Flowers, Flower Parts, Fruits, Related or Similar-Looking Families, and Statistics. Following these features is a list of common California genera and species with both scientific and common name, plant description, and an illustration for many of the species listed.

In the back is an index as well as a glossary with definitions of terms and small illustrations of taxonomic terms that will be useful to amateurs and even trained botanists!

California Plant Families is light weight and would be a great field companion for an amateur. The key to families is easy to use, especially aided with the illustrated glossary of terms.

It is my personal preference that there should be page numbers along side family names in the key. Page numbers following the family names in they key would be beneficial considering the family name is not in the running head at the top of every page; therefore finding the family in the text quickly is a bit tricky.

It is a bit difficult to figure out what vegetation area the book is focusing on. The text insinuates that it's mostly the state west of the Sierran Crest, however, it's not very clear. It seems if so much of the state is covered, the work would have benefited by including all California plant families or one ecological section of the state, whether it be deserts or the Sierras.—*Rebecca Swadek, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

THE DOMINICAN AMBER FOSSIL *LASIAMBIX* (FABACEAE: CAESALPINIOIDEAE?) IS A *LICANIA* (CHRYSOBALANACEAE)

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ABSTRACT

The fossil flower described from Miocene Dominican amber, *Lasiambix dominicensis* Poinar, K.L. Chambers & A.E. Brown, tentatively referred to family Fabaceae subfamily Caesalpinioideae, has been reidentified as clearly a member of the modern genus *Licania*, family Chrysobalanaceae. The new combination *Licania dominicensis* is proposed. The species' affinities appear to be with subgen. *Licania* sects. *Hirsuta* or *Hymenopus*. This is the first report of *Licania* from Hispaniola and the first fossil of the genus from the Greater Antilles.

RESUMEN

La flor fósil descrita del ámbar del Mioceno Dominicano, *Lasiambix dominicensis* Poinar, K.L. Chambers & A.E. Brown, referida tentativamente a la familia Fabaceae subfamilia Caesalpinioideae, se ha reidentificado como un miembro claro del género moderno *Licania*, familia Chrysobalanaceae. Se propone la nueva combinación *Licania dominicensis*. Las afinidades de la especie parecen ser con el subgen. *Licania* sects. *Hirsuta* o *Hymenopus*. Esta es la primera cita de *Licania* de la Hispaniola y el primer fósil del género de las Grandes Antillas.

INTRODUCTION

A further review of the literature on genera of Neotropical angiosperms has led to the discovery that our recently published fossil genus *Lasiambix* (Poinar et al. 2008) is readily referable to the modern genus *Licania*, a member of Chrysobalanaceae widespread in Central and South America (Prance 1972, 1989). Both flowering and early fruiting stages were available for study, including a pre-anthesis flower showing the petals to be early-deciduous. No species of *Licania* are present in the Greater Antilles today (Prance 1989), the nearest occurring ones being *L. michauxii* Prance of the southeastern United States, and *L. leucosepala* Griseb. and *L. ternatensis* Hook. f. of the Lesser Antilles (Nicolson 1991). The genus is well represented in Mexico and Central America and becomes abundant in South America (Prance 1972, 1989).

RESULTS

The following new combination is proposed:

Licania dominicensis (Poinar, K.L. Chambers & A.E. Brown) K.L. Chambers & Poinar, comb. nov. BASIONYM: *Laxiambix dominicensis* Poinar, K.L. Chambers & A.E. Brown, J. Bot. Inst. Texas 2:464. 2008.

In the *Licania* species key of Prance (1989, p. 6), the best fit of *L. dominicensis* is with Key C; the presence of petals, together with the 3 stamens shorter than the calyx lobes, place it in either sect. *Hirsuta* or sect. *Hymenopus* of subgen. *Licania*. The absence of critical features such as leaf shape, texture, venation, pubescence, and inflorescence form does not allow the flower to be assigned to any modern taxon. In addition, its age and its provenance in Hispaniola argue against attempting to place it in any of the ca. 146 described species (Prance 1972, 1989). Based on the floral morphology available in the fossil, its closest relationships to modern species are with *L. costaricensis* Standl. & Steyerm., *L. latistipula* Prance (differing in its connate filaments), and *L. minuscula* Cuatrec. (G. Prance, pers. comm. 2009). The ranges of these taxa are in Central America and northernmost South America, rather than the Lesser Antilles or North America (Prance 1989).

DISCUSSION

The discovery of the species' proper placement in *Licania* corrects its earlier mis-assignment to Fabaceae

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subfamily Caesalpinioideae. The latter was based on our effort to reconcile the simple pistil, presence of a hypanthium, reduced number of stamens placed unilaterally, and drupaceous fruit with some common tropical family.

Dominican amber has been dated as late early Miocene to early middle Miocene (15–20 Ma; Iturralde-Vincent & MacPhee 1996; Graham 2003). It is interesting that within the correct family Chrysobalanaceae, *Licania dominicensis* shows a mixture of putatively apomorphic traits, such as the stamens short, reduced in number, and inserted on one side of the flower, with plesiomorphic ones like the petals present and the hypanthium (receptacle of Prance 1972, 1989) regular and campanulate, with the ovary positioned basally. This combination occurs in numerous modern species in the sections of *Licania* mentioned above, helping to differentiate the genus from relatives such as *Chrysobalanus*, *Couepia*, and *Hirtella* (Prance 1972).

This verified record of *Licania* from the Neogene of Hispaniola may be significant to studies of the spread, by dispersal or vicariance, of tropical forests northward into the Caribbean region, Central America, and North America (Graham 2003; Wendt 1993).

ACKNOWLEDGMENTS

We thank Ghillean T. Prance for his advice and suggestions concerning the similarity of the fossil to particular modern species.

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A NEW COMBINATION IN *LAGOTIS* (PLANTAGINACEAE)

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ABSTRACT

Lagotis glauca Gaertn. subsp. **lanceolata** (Hultén) D.F. Murray & Elven stat. nov. is published.

RESUMEN

Se publica **Lagotis glauca** Gaertn. subsp. **lanceolata** (Hultén) D.F. Murray & Elven stat. nov.

The mainly Asian genus *Lagotis* is represented in North America by *L. glauca* Gaertn., in which there are three taxa, the diploid subsp. *glauca* in the areas surrounding the northern Pacific coasts, the tetraploid subsp. *minor* (Willd.) Hultén (based on *Gymnandra minor* Willd.) in northeastern European Russia and northwestern Asia east to northern Yakutia (the Sakha Republic), and a diploid taxon in northeastern Asia and northwestern North America for which we publish the new combination subsp. *lanceolata* (Hultén) D.F. Murray & Elven (based on *Lagotis glauca* var. *lanceolata* Hultén). Each subspecies is distinct in its main range.

In North America, subsp. *glauca* occurs along the coastline of the Aleutian Islands, Alaska Peninsula, Kodiak Island, the Pribilof Islands, St. Matthew Island, and intermittently north along the mainland coast to Cape Prince of Wales, Seward Peninsula.

Subspecies *lanceolata* in North America occurs farther north and eastward along the Arctic Coastal Plain, Arctic Foothills, and Brooks Range southward to the mountain ranges of interior Alaska, arctic and interior Yukon, and westernmost N.W.T. However, there is a narrow zone along the coast of the Bering Sea where transitional forms occur north to the Seward Peninsula, and thus the rank of subspecies has been chosen. In Asia, this subspecies occurs in Chukotka westward to the Kolyma River and southward to Karaginsky Island, northern Kamtchatka, and the mountains northwest of the Okhotsk Sea.

The two North American subspecies can be distinguished in the following key.

1. Basal leaf blades broadly obovate–oblanceolate, apex rounded or obtuse, sometimes subacute, margins crenate–dentate; filaments ca 1.5 mm or shorter ____ **1a. Lagotis glauca** subsp. **glauca**
1. Basal leaf blades narrowly oblanceolate, apex obtuse or subacute, sometimes acute, margins entire or distantly dentate to serrate; filaments 2 mm or longer ____ **1b. Lagotis glauca** subsp. **lanceolata**

Two names have been applied to the northern, amphi-Beringian plant in the last 50 years: *Lagotis glauca* subsp. *minor* or *L. minor* (e.g., Hultén 1968a, 1968b; Petrovsky 1980; Ivanina 1991; Cody 1996) and subsp. *stelleri* or *L. stelleri* (e.g., Gjærevoll 1967; Porsild & Cody 1980). The application of *L. minor* and subsp. *minor* is erroneous as this name belongs to the European and Asian tetraploid. The names based on *Gymnandra stelleri* which may apply to this plant are problematic for other reasons.

The name *Gymnandra stelleri* has been published twice, but probably based on the same type. Sprengel (1825: 773), when publishing *Gymnandra stelleri* Ledeb. ex Spreng., referred to a collection from "Kamtchatka" but one almost certainly collected in southeastern Siberia, "Sibiria inter Lenam et Oceanum [the Okhotsk

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Sea]," by G.W. Steller, probably in 1740–1741. This collection has not been located, and the diagnosis is not sufficient to identify the plant in question as the Beringian taxon. Chamisso & Schlechtendal (1827: 563), when publishing their own *Gymnandra stelleri,* referred to the Steller collection but not back to the Sprengel publication. Their diagnosis is also not sufficient to identify the plant in question. In addition, they cited three previously published names, among them *Gymnandra minor* Willdenow from 1811, making their name doubly illegitimate. Gjærevoll's (1967), combination "*Lagotis glauca* subsp. *stelleri* Gjærevoll" is of course not validly published as he did not provide a complete reference to the replaced synonym *Gymnandra stelleri* Cham. & Schltdl., Linnaea 2:563. 1827.

This means that there is no validly published name for the amphi-Beringian subspecies, and the names published at other ranks are dubious substitutes for the reasons cited above, with one exception. The exception is *Lagotis glauca* var. *lanceolata* Hultén (Hultén 1930), based on plants from northern Kamchatka and Karaginsky Island, with a diagnosis unambiguously referring to the northern amphi-Beringian plant ("Foliis radicalibus lanceolatis vel ovato-lanceolatis sparse serratis vel crenato-serratis; filamenta vulgo quam in forma typica longiora sed labio superiore distincte breviora") and with a clear reference to several specimens from three specified sites: the Klutchevskaja volcano (five collections, Sedanka—Jelova (one collection), and Karaginsk Island (two collections).

For our treatment of *Lagotis* in volume 17 of *Flora of North America*, we require a valid combination. We base the combination on Hultén's unambiguous, valid, and legitimate name.

Lagotis glauca subsp. **lanceolata** (Hultén) D.F. Murray & Elven stat. nov. *Lagotis glauca* var. *lanceolata* Hultén, Fl. Kamtsch. 4:105. 1930.

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NEOTYPIFICATION OF *HECHTIA PODANTHA* (BROMELIACEAE)

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ABSTRACT

The name *Hechtia podantha* has been frequently misapplied and possesses typification problems, therefore the name is neotypified and its nomenclatural status is discussed. A complete and updated description of *H. podantha* is presented.

RESUMEN

El nombre de *Hechtia podantha* ha sido con frecuencia mal aplicado debido a que presenta problemas de tipificación, por tal motivo se propone su neotipificación y se aclara su estatus nomenclatural. Se presenta una descripción completa y actualizada de *H. podantha*.

In his contribution to the Bromeliaceae for the *Monographiae Phanerogamarum* of C. de Candolle, Mez (1896) proposed seven new species of *Hechtia* using mainly material from Mexico.

In the aforementioned work, Mez described *Hechtia podantha* citing a single collection of material grown in the Schönbrunn garden, which was collected and deposited in the herbarium of the Department of Botany of the Naturhistorisches Museum Wien in Vienna (W) and was cited in the protologue as follows: "Patria absque dubio Mexico. (Descript. ex specimine sicco hort. Schoenbrunn., in herb. Vindob. conserv.)." In 1935, in his contribution to the work of Engler, Das Pflanzenreich, Mez mentioned that the living material had disappeared from the Schönbrunn garden: A *War früher im Schönbrunner Garten in Kultur, ist aber nicht mehr vorhanden*. However, he added to the examined material, one specimen from Tehuacán, Puebla (*Liebmann s.n.*, Dec 1841) and two other collections from Pachuca, Hidalgo (*Pringle 6932*, Aug 1898, and *Pringle 11188*, Aug 1902). Moreover, the original specimen at W was apparently destroyed during World War II, or at least it is not actually found in the collections (W. Till, pers. comm.) (cf. also Merrill 1943, p. 490). Therefore, the type material of *Hechtia podantha* is missing. There is a photograph of the type deposited at the Field Museum (negative 29960, F), in which original label appears with the following text: HRB. MUSEI PALAT. VINDOB. / N°. / Hechtia / C[ulta]. h[orto]. V[indobonensis]. [1]852. However, there are no known duplicates of the original collection at the herbarium and the living material cultivated in Vienna has also been lost.

Currently, the interpretation of this species is based on the original description and in the circumscription made by Mez in Engler Das Pflanzenreich (1935) and by Smith and Downs (1974) in their treatment of the genus for *Flora Neotropica*.

During a taxonomic revision of the *Hechtia podantha* complex (Martínez-Correa 2008), we found that this name was applied to different plant populations with similar morphological characteristics. The inappropriate application of the *podantha* epithet has been the result, at least in part, from the lack of type material that allows the questionable identification of the species, coupled with the lack of suitable specimens.

For the above cited reasons, we believe it is important to review the nomenclatural status of this species and designate a neotype to provide the correct application of the name. Of all the material reviewed by us, we selected specimens collected by C.G. Pringle (6932) in the state of Hidalgo and deposited in several herbaria, whose features match those described for *Hechtia podantha* in the protologue, and also with the photograph of the original material deposited at F (negative 29960).

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We reproduce here the original description of *Hechtia podantha* and provide an updated and detailed description of the species.

Hechtia podantha Mez, in C. DC., Monogr. Phan. 9:549–550. 1896. Type: MEXICO. Hidalgo: municipality of Pachuca de Soto, limestone hills near Pachuca, 8000 ft, 2 Aug 1898, *C.G. Pringle 6932* (neotype, designated here: ENCB!; duplicates of the neotype: B 10 0202857!, BR!, CHAPA!, GH!, LY!, MEXU 8673!, MEXU 154994!, MICH!, P!, UC 117173!, US 334784!, US 934713!, US 958296!, WU 292!, Z 53966! and Z 53987!).

Inflorescentia tripinnatim dense panniculata; ramulis usque ad 60 mm longis, flores cylindrice gerentibus; bracteolis pedicellos usque ad 5 mm longos subaequantibus v. (superioribus) iis brevioribus; sepalis obtusiusculis, glabris; petalis in flore ♂ basi minute cohaerentibus apice late rotundatis; ovario glabro.

Folia ad 0,4 m. longa, supra glabrata, subtus peradpresse minutissime lepidota albida, spinis ad 6 mm longis horrida. Scapus validissimus, ad vaginas albo-floccosus ceterum glabratus. Inflorescentia ∞-flora, ± 0,8 m longa, thyrsoidea; axibus lepidoto-tomentellis glabrescentibus; bracteolis florigeris subulato-lanceolatis, perlonge acutis, ad 4 mm longis. Flores ♀ solum cogniti ex sicco virentes usque ad 5 mm longi; sepalis 4 mm. metientibus, latissime ovatis. Petala elliptica, quam maxime concava. Ovarii in flore × subpulvinatim reducti stigmata sessilia.

Terrestrial herbs, rosetophilous, flowering ca. 1.5 m high. **Stems** short, inconspicuous. **Leaves** numerous, fleshy; sheaths light yellow to brown, ovate to suborbicular, glabrous at the adaxial surface, glabrous at the base and sparsely lepidote at the apex on the abaxial surface, 2.1–8.8 cm long, 2.3–6.1 cm wide, serrate; blades green, erect, narrowly triangular, sparsely lepidote on both surfaces, 19–47.7 cm long, 0.5–1.5 cm wide, pungent, margin spinose; spines curved and ascendent, 3.1–7(–8) mm long, separate by 0.64–3.2 cm. **Inflorescence** terminal, erect, three times branched. **Staminate inflorescence** 44–116.5 cm high, with to 46 primary branches, rachis glabrous, straight, cylindrical; inflorescence internodes 1.2–3.4 cm long; **peduncle** erect, glabrous, cylindrical, 18.3–40 cm long, 0.46–1.1(–1.5) cm diameter, peduncle internodes 0.8–3.1 cm long; inferior **peduncle bracts** foliaceous, sparsely lepidote, serrate, 6.3–17.8 cm long, the upper ones vaginiform, sparsely lepidote, entire; **primary bracts** widely ovate, glabrous, serrulate, 2.2–4.8 cm long; **primary branches** ascendent, cylindrical, one per node, 1.6–6.6 cm long; **secondary branches** ascendent, 1.35–5.25 cm long; **flowers** actinomorphic, numerous per branch, laxely disposed, 3.5–5.8 mm long; **pedicels** 1.4–2.7 mm long; **floral bracts** brown, linear to triangular, glabrous, entire, 1.2–3.1 mm long, 0.2–1 mm wide at the base, 0.1–0.5 mm wide at the middle portion, acute; **sepals** brown, triangular to ovate, glabrous, entire, 1.7–4.3 mm long, 1–2.1 mm wide at the base, 0.7–1.4 mm wide at the middle portion, acute; **petals** green, ellliptic to ovate, glabrous, entire, 2.5–5.4 mm long, 1.4–2.8 mm wide at the base, 1.5–3 mm wide at the middle portion, rounded and brown at the apex; **stamen** equal, longer than petals, filaments 1.3–4.2 mm long, triangular, anthers yellow, oblong, 0.7–2 mm long; **ovary** vestigial. **Pistillate inflorescence** 35–127 cm high, with to 47 primary branches, rachis glabrous, straight, cylindrical, inflorescence internodes 1.2–4.5 cm long; **peduncle** erect, glabrous, cylindrical, 23–68 cm long, 0.73–1.8 cm diameter; peduncle internodes 1.3–4.4 cm long; inferior **peduncle bracts** foliaceous, sparsely lepidote, serrate, 3.8–15.5 cm long, the upper ones vaginiform, sparsely lepidote, entire; **primary bracts** ovate-triangular, sparsely lepidote, serrate, 2.4–6 cm long; **primary branches** ascendent, one per node, 2.5–9 cm long; **secondary branches** ascendent, 1.41–5.31 cm long; **flowers** actinomorphic, numerous per branch, laxely disposed, 3.6–6.4(–7) mm long; **pedicels** 1.6–5.1 mm long; **floral bracts** brown, triangular, entire, glabrous, 1.1–5.3 mm long, 0.1–0.6 mm wide at the base, 0.1–0.4 mm wide at the middle portion, acute; **sepals** brown, triangular to ovate, glabrous, entire, 1.5–4 mm long, 0.7–2.2 mm wide at the base, 0.3–1 mm wide at the middle portion, acute; **petals** green, triangular, glabrous, entire, 1.9–4.7 mm long, 1.4–2.7 mm wide at the base, 0.5–1.6 mm wide at the middle portion, acute; **staminodes** 6, complanate, triangular, anthers absent; **ovary** ovoid, 3.8–7 mm long, 1.2–2.4 mm diameter; **capsule** ovoid, parda, de 0.71–1.2 cm de largo, de 4.1–6.5 mm de diámetro; **seeds** 2–6.8 mm long, with a circumferential wing.

Specimens examined: **MEXICO. Aguascalientes:** Calvillo, 1950 m, 11 Aug 1982, *de la Cerda & Garcia 1482* (CIIDIR, IEB); road to Calvillo, W of Aguascalientes, near km 40, 1850 m, 25 Aug 1960, *McVaugh 18308* (MICH, US); 9 km al NE de Calvillo, sobre la carretera a Aguascalientes, 1800 m, 22 Aug 1976, *Rzedowski & McVaugh 1251* (MICH); *1252* (ENCB, MICH); San José de Gracia, ca. 1 km al S de San José de Gracia, 2000 m, 4 Aug 1996, *López-Ferrari et al. 2245* (UAMIZ); *2246* (UAMIZ). **Guanajuato:** San Luis de la Paz, cerro Santa

Cruz, 8 km al oeste de San Luis de la Paz, 1900 m, 20 Jul 1989, *Ventura & López 6893* (IEB, MEXU, XAL, UAMIZ). **Hidalgo:** Ajacuba, cerro del Tezontle, Sierra del Mexe, ejido Santiago Tezontlale, 2180 m, 30 May 1989, *Díaz & Díaz 456* (FCME, MEXU); Huasca de Ocampo, camino a Piedra Larga (Piedra del Aire), enfrente a Santa Cruz, 1780 m, 12 Nov 2000, *Guízar et al. 5416* (CHAP, MEXU); Huichapan, Huichapan, 19 Jun 1912, *Salazar s.n.* (MEXU); Ixmiquilpan, La Aduana, 10 km después de Ixmiquilpan, rumbo a Zimapán, 1770 m, 28 Aug 2006, *Martínez-Correa et al. 110* (UAMIZ); La Aduana, 1750 m, 10 Nov 1986, *Velasco & Ojeda 174* (CHAP, MEXU); Metepec, Metepec, 17 Jun 1904, *Pringle 13482* (US, VT); Metztitlán, barranca de Metztitlán, paraje La Casita, carretera Pachuca – Tampico, 1100 m, 9 Nov 2000, *Guízar et al. 5291* (CHAP, MEXU); Mineral del Monte, 4 km al N de Pachuca, 2250 m, 4 Aug 1963, *Chávez s.n.* (ENCB); Mineral de la Reforma, alrededores de Pachuca, 2470 m, 28 Aug 2006, *Martínez-Correa et al. 101* (UAMIZ); *102* (UAMIZ); Pachuca de Soto, 3 km al SW de Pachuca, 2550 m, 25 May 1977, *García 2030* (CHAPA, ENCB, IEB, MEXU, XAL); camino de Mineral del Monte a Pachuca. 2640 m, 28 Aug 2006, *Martínez-Correa et al. 104* (UAMIZ); *106* (UAMIZ); *107* (UAMIZ); Cerro Ventoso above Pachuca, 8500 ft, 25 Aug 1902, *Pringle 11188* (B, K, LY, US, Z); between Pachuca and Real del Monte, 31 Aug 1903, *Rose & Painter 6758* (US); 3 km al NE de Pachuca, sobre el camino a Real del Monte, 2550 m, 21 Jun 1963, *Rzedowski 16727* (ENCB, MICH); Tasquillo, Noxthey, 1850 m, May 1981, *Asteinza 316B* (CHAP); ca. 5 km al S de Tasquillo, 10 Jan 1965, *González-Quintero 1984* (ENCB, US); ca. 4 km después de La Aduana, rumbo a Zimapán, en la entrada a Rinconada, 1860 m, 28 Aug 2006, *Martínez-Correa et al. 111* (UAMIZ); *112* (UAMIZ); District Zimapán, by highway near Tasquillo, 12 Aug 1948, *Moore Jr. & Wood Jr. 4508* (AA, MICH, US); *4509* (MICH); Tecozautla, Manguany, 6 km al norte de Tecozautla, 1800 m, 12 Jul 1980, *Hernández-Magaña & Hernández 4696* (MEXU); Tolcayuca, a 2.5 km al SW de Tolcayuca, 2500 m, 7 May 1978, *Equihua 20* (ENCB); Epazoyucan, 2 km al N de La Trinidad, 2500 m, 1 Jun 1973, *Rzedowski 30711* (ENCB, MEXU, MICH); *30712* (ENCB); Zimapán, 2.4 km al W de Las Trancas, rumbo a Zimapán, 1950 m, 20 Jul 1994, *Espejo et al. 5147* (CICY, IEB, UAMIZ); 6 km después de El Saucillo, rumbo a la hidroeléctrica Zimapán, 1970 m, 29 Aug 2006, *Espejo et al. 6889* (UAMIZ); *6890* (UAMIZ). **Querétaro:** Cadereyta de Montes, 6 km después de Mesa de León, rumbo a Cadereyta, 1940 m, 29 Aug 2006, *Espejo et al. 6894* (UAMIZ); 10 km después de Vizarrón, rumbo a Pinal de Amoles, 1700 m, 29 Aug 2006, *Espejo et al. 6895* (UAMIZ); ca. 15 después de Vizarrón, rumbo a Peña Blanca, 1500 m, 9 apr 2007, *López-Ferrari et al. 3249* (UAMIZ); *3250* (UAMIZ); ca. 21 después de Vizarrón, rumbo a Peña Blanca, 1370 m, 9 Apr 2007, *López-Ferrari et al. 3252* (UAMIZ); ca. 18 después de Vizarrón, rumbo a Peña Blanca, 1450 m, 9 Apr 2007, *López-Ferrari et al. 3253* (UAMIZ); La Palma, NE de Mesa de León, en la ceja del río Moctezuma, 1800 m, 1 Aug 1998, *Pérez et al. 3867* (IEB, UAMIZ); Ezequiel Montes, 4 km al E de Las Rosas, 1850 m, 19 Jul 1989, *Zamudio 7393* (IEB); *7397* (IEB); Peñamiller, 5 km después del puente Chorreadero, carretera Vizarrón - Pinal de Amoles, 1360 m, 29 Aug 2006, *Espejo et al. 6897* (UAMIZ); 6 km al S de Peña Blanca, 1450 m, 14 Jul 1979, *Zamudio 3680* (IEB, MEXU); Querétaro, La cañada, ladera norte, 15 Mar 2002, *Cabrera 102* (IEB); San Juan del Río, Cerro Gordo, 8 km al SW de la cabecera municipal de San Juan del Río, 26 Jun 1987, *Rodríguez & Osorno 13* (CHAPA, CIIDIR, IEB). **Nova Hispana:** Sin localidad precisa, (1787–1795–1804), *Sessé et al. 4667* (MA); C[ulta]. h[orto]. V[indobonensis]. [1]852, cult. Schönbrunn (foto F!).

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BOOK NOTICE

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FOUR NOMENCLATURAL CHANGES IN *VIOLA* (VIOLACEAE)

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ABSTRACT

In keeping with the use of varieties for infraspecific taxa in the treatment of *Viola* for the *Flora of North America*, four nomenclatural changes are proposed here to achieve consistency.

RESUMEN

De acuerdo con el uso de variedades para taxa infraspecificos en el tratamiento de *Viola* para la Flora de Norteamérica, se proponen aquí cuatro cambios nomenclaturales para conseguir coherencia.

Viola epipsila Ledeb. var. **repens** (Turcz. ex Trautv. & C.A. Mey.) R.J. Little, stat. nov. Basionym: *Viola repens* Turcz. ex Trautv. & C.A. Mey., Fl. Ochot. (Aus A. Th. v. Middendorff's. Sibir. Reise Band 1 Theil 2 besonders abgerdruckt) 18. 1856, non Schwein. 1822. *Viola epipsila* subsp. *repens* (Turcz. ex Trautv. & C.A. Mey.) W. Becker, Bot. Centralbl. Beiheft 34(2):406. 1917.

The acaulescent, rhizomatous, *V. epipsila* var. *epipsila* occurs in Europe and northwest Asia. *Viola epipsila* var. *repens* occurs in Europe, eastern Asia, Alaska, and western Canada. Variety *repens* differs from var. *epipsila* by its smaller size, its glabrous, abaxial leaf surfaces (Baird 1942), by its distinctly acute leaves, and larger flowers (Sorsa 1968). Baird and Sorsa noted that bracteoles of *V. epipsila* occur above the middle of the peduncle, a character used to differentiate it from *V. palustris*. The Violaceae treatment in the recent Flora of China (Yousheng et al. 2008) treated *V. repens* as a synonym of *V. epipsiloides* A. Löve & D. Löve. However, other authors do not recognize *V. epipsiloides* and consider *V. repens* as a subspecies of *V. epipsila* (Cody 2000; Douglas 2000; Karlsson et al. 2008).

Viola pedatifida G. Don var. **brittoniana** (Pollard) R.J. Little & L.E. McKinney, stat. nov. Basionym: *Viola brittoniana* Pollard, Bot. Gaz. 26:332. 1898. *Viola pedatifida* G. Don. subsp. *brittoniana* (Pollard) L.E. McKinney, Sida, Bot. Misc. 7:22. 1992.

This violet was originally described as *V. atlantica* by N.L. Britton (1897), but the name was invalid due to an earlier homonym. Britton considered this violet as simulating *V. pedatifida* apparently making him the first to consider the affinity between var. *brittoniana* and *V. pedatifida*. Both are homophyllous species and are quite similar in many other characters leading L.E. McKinney (1992) to follow Britton's lead and to fully establish the relationship between these two taxa. *Viola pectinata* is considered to be a sporadic form and as Russell (1965) suggested, is likely due to genetic dimorphism. Additional studies are necessary before considering *V. pectinata* as anything other than a dimorphic form.

Viola praemorsa Douglas ex Lindl. var. **flavovirens** (Pollard) R.J. Little, stat. nov. Basionym: *Viola flavovirens* Pollard, Bull. Torrey Bot. Club 24:405. 1897. *Viola praemorsa* Douglas ex Lindl. subsp. *flavovirens* (Pollard) Fabijan, Canad. J. Bot. 65:2579. 1987.

Piper and Beattie (1914) and subsequent authors treated this taxon as synonymous with *V. praemorsa* ssp. *major sensu* Baker (Fabijan et al. 1987). The size of the basal and cauline leaves are among the diagnostic features separating the three varieties of *V. praemorsa*. The basal and cauline leaves of var. *flavovirens* are usually longer (basal to 17 cm long; cauline to 14.8 cm long) and wider (basal to 6.7 cm wide; cauline to 5.5 cm wide) than vars. *linguaefolia* or *praemorsa* (basal to 8.5 cm long, to 3.7 cm wide; cauline to 8 cm long, to 3.5 cm wide). Fabijan et al. (1987) reported that Baker and Clausen annotated herbarium sheets with *flavovirens* as a subspecies or variety of *praemorsa* indicating that they recognized the taxon. However, no revision of its taxonomic status had been published prior to Fabijan (Fabijan et al. 1987).

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Viola sororia Willd. var. **grisea** (Fernald) L.E. McKinney, comb. nov. Basionym: *V. septentrionalis* Greene var. *grisea* Fernald, Rhodora 37:301, pl. 375. 1935. *Viola sororia* Willd. var. *novae-angliae* (House) McKinney, Sida, Bot. Misc. 7:44. 1992. *Viola novae-angliae* House, Rhodora 6:226. 1904.

Gil-Ad (1997) considered *Viola novae-angliae* to be a distinct species as did Ballard and Gawler (1994); they suggested it might be a hybrid derivative between *V. sororia* and *V. sagittata*. Brainerd (1921) considered it closely related to *V. septentrionalis*, which is included in *V. sororia* var. *sororia* in the forthcoming FNA treatment.

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DIVERSITY, NATURAL HISTORY, AND CONSERVATION OF *VANILLA* (ORCHIDACEAE) IN AMAZONIAN WETLANDS OF MADRE DE DIOS, PERU

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ABSTRACT

Investigations of the diversity and natural history of *Vanilla* are scarce, especially in the Amazon region. Considering that the cured, fragrant fruits of several species are traded in international markets and are an important cash crop for thousands of small-scale farmers in tropical regions, there is a surprising lack of published information concerning *Vanilla* in the botanical literature. This paper presents the results of a study of six *Vanilla* species that occur primarily in wetland ecosystems of Madre de Dios, Peru, in the southern Peruvian Amazon. While extremely rare outside wetlands, the genus is one of the most conspicuous elements of wetland vegetation due to its high visibility and abundance, yet it is virtually unknown even to local residents. Here we describe each species in detail with notes and observations from field studies of their natural history. We also offer a key for their identification. We conclude with a discussion of conservation implications and recommendations for continued investigation of *Vanilla* orchids and their Amazonian wetland habitats.

Key Words: *Vanilla*, Orchidaceae, Peru, Amazon, wetlands, diversity, natural history

RESUMEN

Investigaciones de la diversidad e historia natural de *Vanilla* son escasos, especialmente en la Región Amazónica. Considerando que sus frutos curados y fragantes provenientes de diversas especies son comercializados en mercados internacionales y que son una considerable fuente de ingreso para miles de productores de pequeña escala en las regiones tropicales, resulta sorprendente la ausencia de información publicada acerca de *Vanilla* en la literatura botánica. Este artículo presenta los resultados del estudio realizado en seis especies de *Vanilla* provenientes de los humedales de Madre de Dios, Peru, ubicados al sur de la Amazonia Peruana. Si bien es extraño observarlo fuera de humedales, este género es uno de los elementos más conspicuos en la vegetación inundable debido a su visibilidad y abundancia, y aun así es virtualmente desconocido para los lugareños. En el presente artículo se describe cada especie en detalle con notas y observaciones de estudios de campo y de su historia natural, e inclusive ofrecemos una clave para su identificación. Para finalizar concluimos con una discusión de las implicaciones en su conservación y recomendaciones para realizar investigaciones posteriores en *Vanilla* y de su habitat inundable amazónico.

INTRODUCTION

Vanilla Plum. ex Mill. is a pantropical genus of the Orchidaceae comprising more than 100 species of epiphytic and terrestrial lianas. It is noteworthy among the genera of the Orchidaceae tribe Vanilleae as the most species-rich, widespread genus (Stern & Judd 1999). Based on recent molecular studies the vanilloid orchids are recognized as an ancient lineage that deserves to be treated as a subfamily of the Orchidaceae (Chase et al. 2003; Cameron 1999). Such attributes highlight *Vanilla* as key to understanding the orchid family, arguably the most species-rich group of plants on the planet, calling for further studies of the diversity and natural history of this genus.

Taxonomic investigations are scarce or incomplete and the genus is plagued by lack of collections, misidentifications of existing collections, poor understanding of species concepts, and a conflicting synonymy

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(Chevailer 1946; Correll 1946). Two major revisions of the genus by Rolfe (1896) and Porterès (1954) are largely out of date. Recent molecular studies (Bouetard et al. 2010; Soto-Arenas & Dressler 2010) have greatly improved our understanding of the phylogenetic relationships between species; however, these are still tentative and incomplete. Soto-Arenas and Cribb (2010) have recently revised the infrageneric classification of the genus, lamenting that our knowledge of *Vanilla* is far from adequate to produce a good, modern revision.

Exacerbating taxonomic problems, there is a deficit of natural history studies and the observations that come from them, such that even basic information concerning dispersal mechanisms and pollinator relationships remains enigmatic. Several characteristics of the group make detailed investigation, documentation, and collection difficult. First, *Vanilla* species often occur in low-density populations that are hyper-dispersed in local areas of their limited geographic ranges (Soto-Arenas et al. 2003). This has contributed to the lack of herbarium collections and basic natural history data. Second, plants are usually encountered without flowers as many species require pendant growth in bright light to initiate budding. Third, the succulent nature of the plants renders them very slow to dry and botanical collectors often avoid them as logistically problematic. Finally, *Vanilla* species often have delicate, ephemeral flowers that do not preserve well on herbarium specimens.

From an economic perspective, cured *Vanilla* fruit provide the world's major source of natural vanilla fragrance and flavoring. In 1995, fruits from *Vanilla planifolia* ranked as the leading U.S. spice import on par with black pepper (Buzzanell & Gray 1995). World production estimates in 2001 of approximately 2300 metric tons (Loeillet 2003) are generally restricted to developing tropical countries with a cheap labor force (Koekoek 2005; Anonymous 2003). The crop is important to thousands of small-scale farmers worldwide, with highest production coming from Madagascar and Mexico (Hermans and Hermans 1995). However, the narrow genetic base of commercial *Vanilla planifolia*, due to strictly vegetative propagation, and its growing susceptibility to viral and fungal pathogens suggest that the industry has not fully explored the genetic resources harbored by potentially disease-resistant wild species (Besse et al. 2004; Grisoni et al. 2004; Bory et al. 2008).

Modern studies of the diversity and natural history of *Vanilla* are needed in the Amazon. Amazonian species of *Vanilla* have been poorly collected and are little known in comparison with Central American species (Soto-Arenas, pers. comm. 2007). During ongoing studies of the diversity, natural history, and conservation of wetland plants and ecosystems in Madre de Dios, Peru, by the Botanical Research Institute of Texas (BRIT), six *Vanilla* species have been encountered. The goal of this paper is to provide an updated report of the diversity of *Vanilla* species in Madre de Dios wetlands, with comparisons to the historical collection record and knowledge of the genus in the Amazon. Most species are newly recorded for Peru. Morphological descriptions and a key are provided along with notes and observations to document current knowledge of the distribution, habitat, and natural history of each species. We follow this with a discussion of important conservation implications.

MATERIALS AND METHODS

Study Site

All studies were carried out along the Madre de Dios River watershed in the Department of Madre de Dios, located in southeastern Peru and corresponding to the headwaters of the southwestern Amazon (Fig. 1). The region is widely recognized as a hotspot of biological and cultural diversity that is partially protected by a series of large conservation areas, including Manu National Park, Bahuaja-Sonene National Park, the Tambopata Reserved Zone, Los Amigos Conservation Area and the Amarakaeri Indigenous Reserve. The study region includes flat lowland habitat ranging in elevation from 300 to 350 m classified as humid tropical forest. Wetlands with hydromorphic soils, generally dominated by palms, are a patchy, but ubiquitous aspect of the landscape in topographical depressions and in the vicinity of seepages (Kahn 1987; Kahn & Mejia 1990). Along current river floodplains wetlands are a prominent habitat, becoming quite extensive and ranging in size from 10 to 3000 ha.

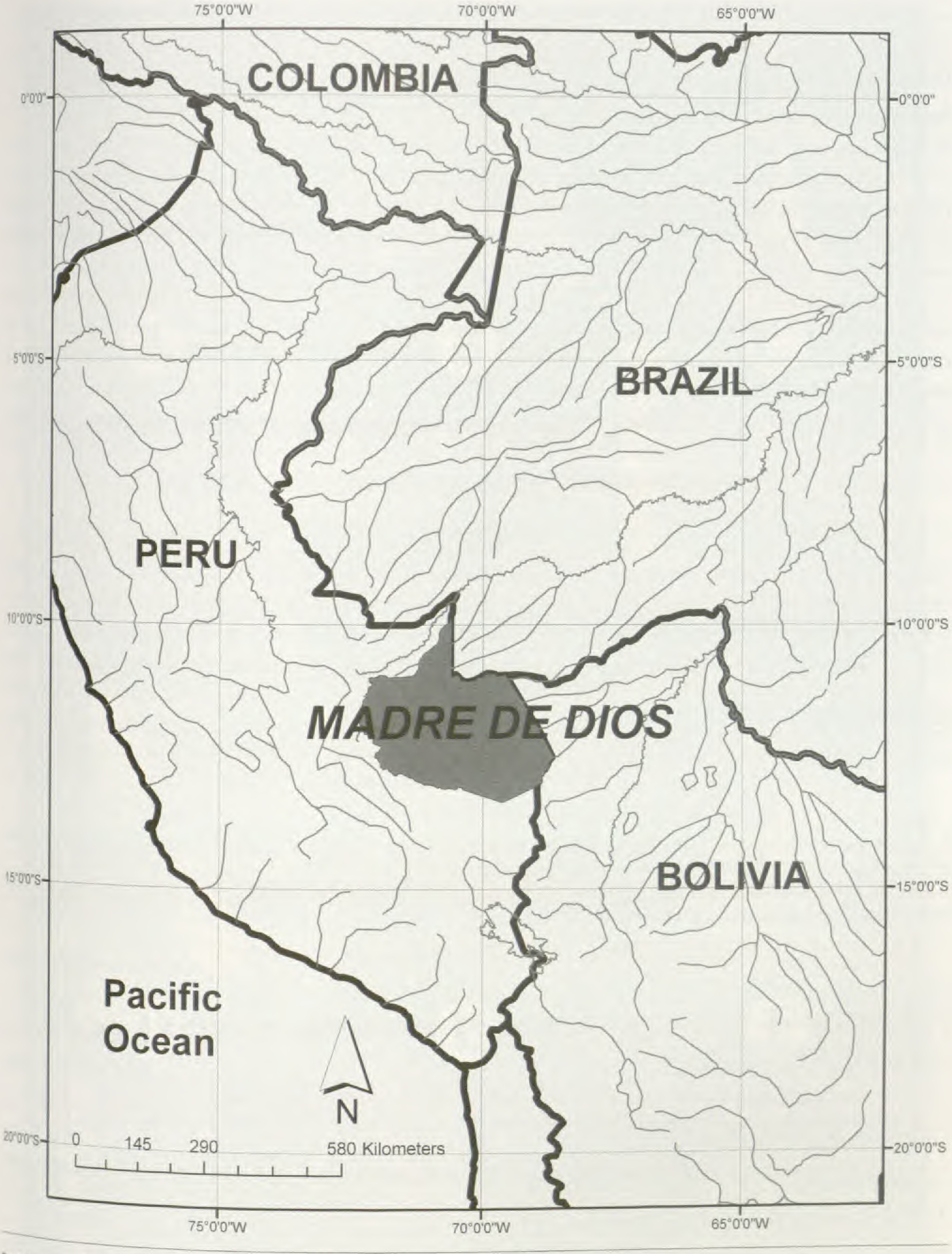
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Fig. 1. Location of study region.

Annual average rainfall ranges between approximately 2,000 and 3,500 mm. Rainfall is unevenly distributed throughout the year, with greater than 80% falling between October and April. Average daily temperature ranges from 21 to 26°C. Southerly cold fronts from Patagonia, known as "*friajes*," are common from June through August, rapidly decreasing temperatures by 10°C or more in a matter of minutes;

sustained for a period of several days, temperatures as low as 10°C have been reported. Climate data since 2001 is made available by the Amazon Conservation Association through the weather module of the Atrium Biodiversity Information System at BRIT (http://atrium.andesamazon.org).

Specimen and Data Collection

Between July 2005 and August 2009, approximately 70 km of line and trail-based transects were surveyed in 28 separate wetlands throughout Madre de Dios. Transects varied in length according to wetland size, ranging from 4 km in the largest wetlands, to 1 km in the smallest. All transects were oriented strategically to cross a diversity of wetland vegetation formations. Accessible populations of the most common *Vanilla* species were frequently monitored for phenological patterns. Opportunistic observations were made to document the activity of bees visiting flowers and fruits. If possible, photos and specimens of pollinators were collected for subsequent identification. Pollination rates for all species were estimated at the end of the flowering season by counting the number of empty floral bracts and fruits. Descriptions of floral scents were facilitated by enclosing the entire flower in a plastic film container for five minutes to intensify the fragrance. Plant specimens were collected in duplicate sets and deposited at the San Marcos Herbarium (USM) in Lima, Peru, and the BRIT Herbarium. Fresh flowers and fruits from each collection were photographed and preserved in 90% alcohol for descriptive studies.

RESULTS

Six species of *Vanilla* were encountered and documented in the wetlands of Madre de Dios. The following key is based primarily on morphological characteristics that are most useful in the field. Several species are notoriously variable in their morphology but proper identifications are not difficult even in sterile condition using a combination of vegetative and ecological characteristics. Climbing individuals attached to a host are generally much easier to key out and identify in the field than are scrambling vines. The key is followed by morphological descriptions of each species with notes about nomenclature, distribution, habitat, and natural history.

KEY TO SPECIES

1. Leaves membranaceous, thin, rostellum absent, flowers not resupinate **1. V. guianensis**
1. Leaves succulent, thick, rostellum present, flowers resupinate.
  2. Leaves narrowly lanceolate, sepals green **2. V. riberoi**
  2. Leaves ovate, obovate, or elliptic, possibly highly variable even on same vine, sepals yellow or red-brown.
    3. Stems > 1 cm in diameter, generally a massive terrestrial vine up to 20 m, raceme strictly axillary **3. V. pompona subsp. grandiflora**
    3. Stems < 1 cm in diameter, short (< 5 m in length) vine or epiphyte, racemes terminal and axillary on same plant.
      4. Leaves obovate with cuspidate apex, generally held horizontal to ground, always terrestrial vine, callus compact **4. V. cristato-callosa**
      4. Leaves ovate to elliptic with acute apex, mostly epiphytic, callus diffuse or absent.
        5. Leaves petiolate, discolorous with pale red-brown outline, internode length > than leaf length, sepals red-brown **5. V. bicolor**
        5. Leaves sessile, entirely green, internode length < than leaf length, sepals yellow **6. V. palmarum**

1. Vanilla guianensis Splitg. (Fig. 2a).

Plant a vine, occasionally reaching up to 10 m. Stems thin, brittle, ca. 0.4–0.7 cm in diameter, internodes 8–10 cm long, one to many-branched. Aerial roots short, thin, ca. 0.2 × 3 cm, unbranched. Terrestrial roots emerging from lower nodes and entering superficially into substrate, branched underground. Leaves alternate, produced from each node opposite to roots, distichous, thin and membranaceous; blade elliptic, ca. 3.7–11 cm wide and 7.5–22 cm long, green, apex acute-attenuate, margins entire. Inflorescences axillary, racemose, sessile, 2–20 flowered, fleshy, green; bracts triangular, ca. 1 cm long, green; pedicel ca. 0.3 cm wide and 3 cm long (pedicel of auto-pollinating individuals may be longer because fruit development begins

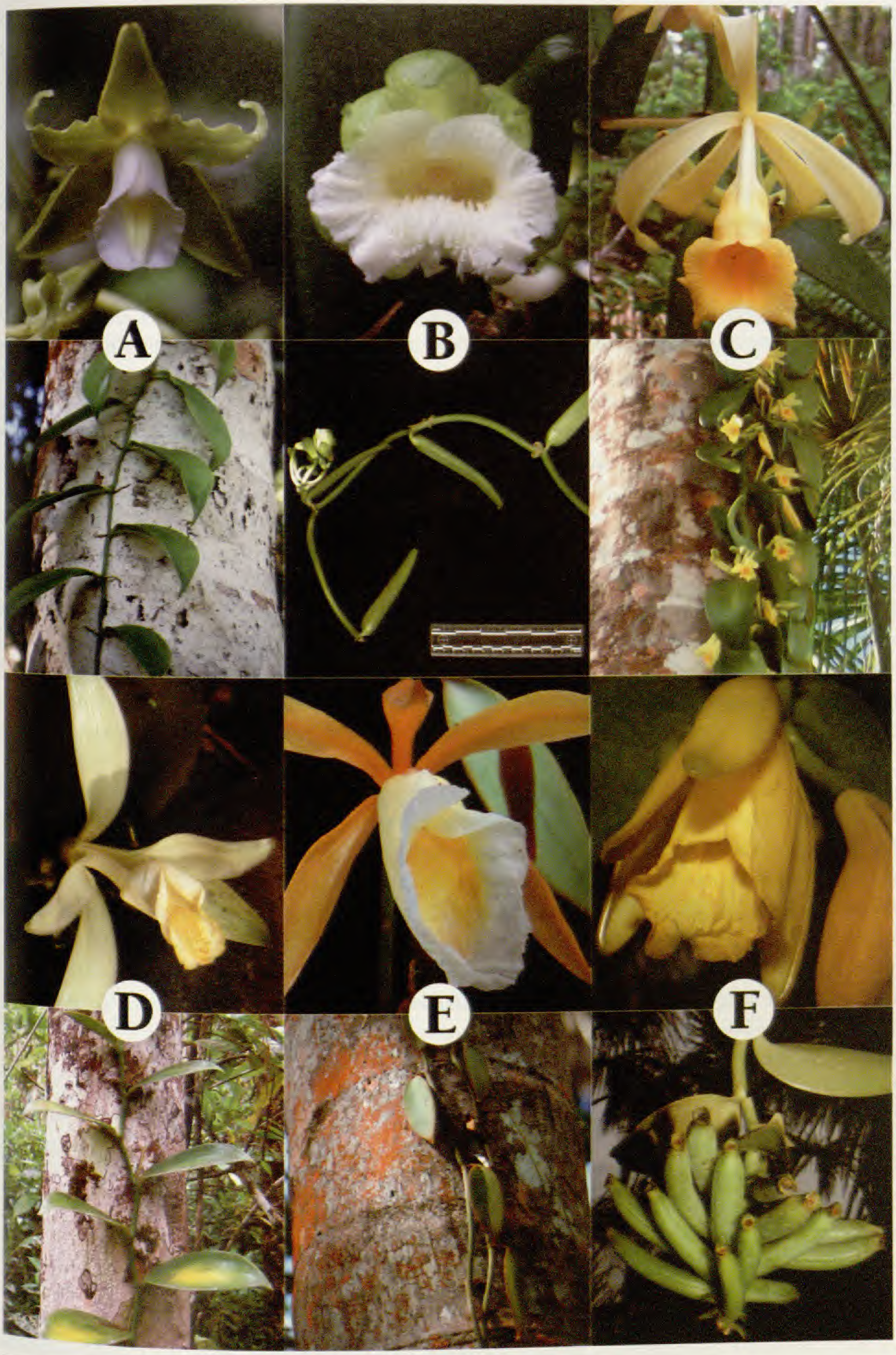

FIG. 2. Images of *Vanilla* species flowers (top) and vines in their natural habitat (below). **A.** *V. guianensis*. **B.** *V. riberoi*. **C.** *V. pompona* subsp. *grandiflora*. **D.** *V. cristato-callosa*. **E.** *V. bicolor*. **F.** *V. palmarum*.

in bud stage), pale yellow-green in color. Flowers not resupinate, fleshy, very stiff, ca. 7 cm wide, distichous on raceme, slightly fragrant (like freshly cut grass or trunk slash); buds green; sepals elliptic, undulate, ca. 1.7 × 4 cm, green, apex acute, margins keeled; petals elliptic, often strongly recurved, undulate or not, ca. 1.2 × 4 cm, green, apex acute; lip stiff, white, glabrous, forming triangular opening when fresh, attached to column on dorsal side for 0.4 cm of length, when flattened broadly pentagonal in shape, distinctly three-lobed; middle lobe 3 cm long, adaxial surface with distinctive yellowish channel formed from two broadly raised longitudinal keels, abaxial surface with distinct longitudinal furrow; lateral lobes white, ca. 1.8 cm long, stiff; callus absent; column 2.4 cm long, 0.4 cm wide, stiff, forks 0.4 cm from tip of stigma, upper fork holds anther ca. 0.3 cm beyond stigma; rostellum absent; anther ca. 0.2 × 0.2 cm with red-orange margins; stigma ca. 0.05 × 0.2 cm, with four nipple-like projections. Fruit dehiscent, cylindric, ca. 1 × 18 cm, green and brittle when immature, splitting longitudinally along sutures, splitting valves turn dark brown, pliable, leathery, revealing seeds within a somewhat oily mesocarp, with disagreeable fragrance when moist.

Notes.—This species has a complicated nomenclature, with no type specimen and several synonyms. The oldest name is *V. guianensis* Splitg. and thus conserved. However, it may also be found as *V. acuta* Rolfe, *V. latisegmenta* Ames, and *V. surinamensis* Rchb. f. (Soto-Arenas & Cribss 2010). Soto-Arenas and Cribb (2010) place it in subgenus *Vanilla*, subsection *Membranaceae*, a group characterized by its thin leaves, continuous endoderm, large number of row fibers in the stem, and little differentiation between vegetative and reproductive axes (Soto-Arenas 2003).

Habitat and Distribution.—This species is relatively common throughout the Amazon basin (Soto-Arenas, pers. comm.). Although in our study region it occurs more abundantly in association with *M. flexuosa* wetlands, it is the only species not strictly restricted to wetlands. For example, we have documented individuals growing in managed banana plantations, suggesting that it is a fast-growing, colonizing species. In *M. flexousa* wetlands with deep histosols and acidic waters it generally prefers areas with abundant, low-lying, shrubby trees common to wetlands, such as *Ilex sp.* (Aquifoliaceae), *Tapirira guianensis* (Anacardiaceae), and *Tabebuia insignis* (Bignoniaceae). The leaf litter of these common, non-palm wetland trees may be important in seedling germination.

Natural History.—Flowering phenology is somewhat sporadic; various individuals flowered in January, April, May, and November during 2005–2006. The number of flowers per individual ranged from 5 to about 50, depending on plant size. Flowers often open in triplets and remain open for three to seven days as observed for other membranaceous species (Soto-Arenas et al. 2003). Due to longer flower longevity and rapid rates of anthesis a large floral display often accumulates on reproductive branches. The most gregariously flowering branches are almost always those that are pendent, hanging from the main vegetative axis.

Vanilla guianensis is apparently self-pollinated at early anthesis as the stigma and anther grow to contact one another. Pollination rates are approximately 78% (Table 1). No potential pollinators have been observed, but Soto-Arenas (2003) suggests that the stiff flowers and relatively closed throat of *V. guianensis* may be adapted to large, strong pollinators such as carpenter bees (*Xylocopa* spp). However, no potential pollinators have been observed near flowers of *V. guianensis* in wetlands.

Unlike other *Vanilla* species, the flower and column of *V. guianensis* rapidly abscise from the developing fruit. Once mature, dehiscing fruits have a rather unpleasant, putrid odor for one to several days. While such odors may be attractive to some animal dispersers, none, however, have been observed near fruits. The separated valves may remain oily and pliable for several weeks and when dry become leathery. The thin fibrous stems do not readily propagate vegetatively in artificial settings.

2. **Vanilla riberoi** Hoehne (**Fig. 2b**).

Plant a vine, generally loosely climbing on understory trees. Stems dark green, succulent, ca. 0.5–0.8 cm in diameter, internodes 10–15 cm long. Aerial roots produced from each node, short, stout, white, unbranched. Terrestrial roots emerging from lower nodes and entering superficially into substrate, branched and extensive underground. Leaves alternate, produced from each node opposite to roots, distichous, held at 0 to 15 degrees below horizontal, succulent; blade narrowly lanceolate-linear, ca. 1.5–2 cm wide and 8.5–14 cm

Table 1. Pollination rates of each *Vanilla* species. Rates were calculated as the total number of fruits divided by the total number of bracts. Counts were timed at the end of the flowering season. **Auto-pollination was tested by placing 1mm mesh bags over racemes.

Species	Counts				Pollination rates %	Pollination mechanism
	Bracts	Fruits	Racemes	Individuals		
V. bicolor	31	22	13	13	71	auto**
V. palmarum	37	26	3	3	70.3	auto
V. guianensis	163	127	38	8	78	auto
V. pompona grandflora	5405	50	Not calculated	148	0.9	*Eul. meriana*
V. cristato-callosa	209	14	16	12	6.6	Euglossine
V. riberoi	88	1	12	3	1.1	Euglossine

long, dark green when fresh, texture smooth, apex acute, margin entire. Inflorescences axillary only, racemose, fleshy, green, sessile ca. 1 to 20-flowered; bracts triangular, ca. 1.8 cm long and 1 cm wide, green, non-floriferous bracts generally two; pedicel ca. 0.5 × 4.5 cm, white at base to three-quarters length then fading to green. Flowers resupinate, somewhat stiff, fleshy, span ca. 4–5 cm, arranged spirally, non-fragrant; buds green; dorsal sepal oblanceolate, ca. 1 × 5 cm, green, apex rounded; lateral sepals oblanceolate, ca. 1.4 × 4.7 cm, green, apex rounded; petals linear, ca. 1 × 4.6 cm, green, ribbed dorsally; lip saccate when fresh, reflexed, stout, ca. 3.8 cm long, white, fused with column for two-thirds length dorsally, flabellate when flattened, unguiculate, the claw of white hirsute-papillose hairs forming patch ca. 1.5 × 1 cm on opening of ventral surface, margin revolute; callus wide, ca. 0.5 × 0.4 cm, penicillate with wide laciniate scales; column strongly concave, ca. 2.7 cm long, 0.4 cm wide, adaxial surface hirsute; rostellum thick, wide; stigmatic surface two-lobed. Fruit dehiscent, cylindric in cross-section, green and brittle when immature, splitting longitudinally along sutures, splitting valves turning dark brown, pliable, revealing seeds in somewhat oily mesocarp, pleasantly fragrant.

Notes.—Soto-Arenas and Cribb (2010) place *V. riberoi* in subgenus *Xanata*, section *Xanata*.

Habitat and Distribution.—This species has been previously collected from inundated areas of Mato Grosso, Brazil, near the Bolivian border, Columbia, and Guyana. Of the indigenous terrestrial *Vanilla* species in Madre de Dios, it is the most tolerant of substantial water level fluctuations and we have documented its prescence in at least four habitats, all with varying flood regimes: permanently inundated *M. flexuosa* wetlands on histosols, aseasonally inundated *M. flexuosa* wetlands on gleysols, seasonally inundated *shebonales* dominated by *Attalea* sp. (Arecaceae), and small forest patches (usually in association with arborescent palms) characterized by clayey soils that retain water after precipitation events. Although this is one of two *Vanilla* species not restricted to *M. flexuosa* wetlands, it is restricted to areas with hydromorphic soils.

Natural History and Reproduction.—The flowering season occurs in mid-August to September, just prior to the main flowering season of *V. pompona* subsp. *grandiflora*, and their phenologies partially overlap. Ephemeral flowers open singly and last a single day. Pollination rates are low, estimated to be about 1% based on three fertile individuals studied (Table 1). Nothing is known about pollinators, but such low pollination rates suggest outcrossing by insect vectors, probably Euglossine bees.

3. **Vanilla pompona** Schiede subsp. **grandiflora** (Lindl.) Soto-Arenas (**Fig. 2c**).

Plant a robust, succulent vine climbing up to 30 m. Stems green, thick, succulent, ca. 0.9–2.3 cm in diameter; internodes 9–13 cm long for climbing individuals, one to many-branched, when tissues are damaged the sap is slightly irritating when rubbed. Aerial roots produced from each node, short, stout, white, unbranched, ca. 0.5 cm in cross-section, ca. 3–5 cm long. Terrestrial roots emerging from lower nodes and entering superficially into substrate where branched and extensive. Leaves alternate, produced from each node opposite to roots, distichous, held at 30 to 60 degrees below horizontal, succulent, sessile; blade highly variable in size and shape, elliptic to suborbicular, ca. 3–13 cm wide and 6–30 cm long, texture smooth, apex slightly cuspidate to rounded, margin entire. Inflorescences axillary, racemose, fleshy, green, sessile, ca. 1 to 20-flowered; bracts triangular, ca. 1.5 cm long, green; pedicel green, persistent on maturing fruit. Flowers resupinate, tender, fleshy, span ca. 15 cm wide, arranged spirally, fragrant or not, remaining attached to ovary if successfully pollinated; buds green; dorsal sepal oblanceolate, reflexed when fully open, ca. 1.5 × 9.4 cm, yellow; lateral sepals oblanceolate, reflexed, ca. 1.5 × 8.5 cm, yellow; petals oblanceolate, reflexed, ca. 1.1 × 9 cm, yellow, with thickened midvein on dorsal surface; lip somewhat saccate when fresh, fused with column for ca. 5 cm, uniformly yellow except for a characteristic pale, triangular discoloration on ventral surface of opening, flabellate and almost triangular when flattened, margins slightly revolute, pleated, unguiculate, the claw caniculate with dark yellow rows of trichomes running longitudinally between lip margin and callus, ca. 2.2 cm long and 0.3 cm wide,; callus well-developed, ca. 0.8 × 0.6 cm, penicillate with laciniate scales; column ca. 6.3 cm long, 0.4 cm wide, hirsute on ventral surface near rostellum gradually becoming glabrous; rostellum broad, thick, yellow. Fruit dehiscent, ca. 2.6 × 15 cm, fleshy, triangular in cross-section, green and brittle when immature, splitting longitudinally along sutures into unequal valves at maturity, split ends turn pliable, leathery and brown-black in color, revealing seeds embedded within an extremely oily mesocarp and emitting strong vanillin fragrance.

Notes.—*Vanilla pompona* subsp. *grandiflora* is a member of the subgenus *Xanata*, section *Xanata*. New molecular data suggest that the *V. pompona* of Mexico is nested within the variable *V. grandiflora*, but the older name, *V. pompona*, is retained (Soto-Arenas pers.comm.). The species complex is quite variable and several disjunctions are evident within its widespread distribution (Soto-Arenas & Dressler 2010). The original species described by Schiede, now *V. pompona* Schiede subsp. *pompona*, is a narrow endemic on the Mexico/Guatemala border and all records of its existence in South America are wrong.

Distribution and Habitat.—*Vanilla pompona* subsp. *grandiflora* is widely distributed from Honduras to Bolivia (Soto Arenas pers. comm.). In Madre de Dios it is mostly restricted to open, flooded savannah habitat within *Mauritia flexuosa* wetlands, characterized by deep, permanently saturated histosols and minimal water level fluctuations. While the vine is robust and resilient to frequent disturbances caused by falling palm fronds, its roots are vulnerable to even short periods of inundation. Within its habitat it is generally restricted to small hummocks formed by the accumulation of *M. flexuosa* frond mulch. It often forms dense populations over extensive areas where conditions are favorable.

Natural History.—On a given inflorescence flowers open singly every two to three days. Flowers open as early as 3:00 am and generally last 12–15 hours, wilting with the afternoon heat. Individuals tend to flower more profusely immediately following small-scale (5 C° or less are sufficient) temperature reductions (i.e., *friajes*). During these cool weather spells, up to two flowers may open per inflorescence and we have observed displays of over 30 open flowers on a single individual. Flowering responses to temperature seem to be facilitated by determinant racemes with buds almost fully developed prior to the initiation of the flowering season. Several of the most fully developed, basally located buds may be poised to open during unpredictable cool spells. The response to cool temperatures is general and immediately following *friajes* the entire population may not flower for one to several days while apically located buds develop. The maximum number of flowers observed on a single individual throughout an entire season was 200. Flowering phenology is bimodal, with two rather short flowering episodes of approximately 30 days each in April and September/October. Significantly more individuals flower during the September/October season, probably in response to the long dry season commencing in June/July.

The flowers produce a "sweet" fragrance, but this is sometimes barely perceptible and the potency varies between individuals. Particularly fragrant flowers attracted two species of Euglossine bees, *Euleama meriana* and *Euglossa imperialis*. Several individuals of both species may repeatedly circle a single fragrant flower for several minutes, often demonstrating antagonistic behavior. The smaller, and generally more numerous *Eug. imperialis* is the more aggressive species, however its small size probably precludes it as an actual pollinator. We have observed only *Eul. meriana* to pollinate flowers on two occasions. In both cases a solitary bee entered the floral tube for two to four seconds and with no delay departed along a straight line track. Collection of fragrance of floral origins has never been observed, suggesting that flowers are deceptively pollinated (see Lubinsky et al. (2006) for a more detailed description).

Pollination rates are extremely low, measured at less than 1% in September 2005 (Table 1). The number of fruits per individual ranged from one to four, the great majority of fruiting individuals producing only a single fruit during any given season. Fruits mature and begin to dehisce approximately five to nine months after pollination and open slowly over a period of approximately two weeks, revealing thousands of tiny seeds embedded within an extremely oily mesocarp. The green, brittle fruit turns dark brown and pliable as it opens. This process begins at the fruit apex and is usually preceded by a slight yellowing of the exocarp. Mature (dehiscing) fruits have a sweet vanilla aroma. Fruit fragrance is attractive to a limited number of bee species, interestingly including the two Euglossine species attracted to floral fragrance, *Eul. meriana* and *Eug. imperialis*. Both species demonstrate typical fragrance collection behavior (see Dressler (1968) for a detailed description of fragrance collection behavior) and may remain at a single fruit for over 15 minutes. While they may land on any part of the fruit, there seems to be intense competition for the most recently opened (probably most fragrant) section. Other common bee visitors include a single species of stingless bee (*Trigona* sp.), and one species of carpenter bee (*Xylocopa* sp.). The species of *Trigona* has been observed to collect and fly away with small packets of twenty seeds on their hind tibia. Although not confirmed, the tiny seeds embedded in the fragrant, oily mesocarp may also be intentionally collected by the Euglossine bees during fragrance collection. Nothing is known about the fate of these seeds once collected, however we have often observed *Trigona* bees dropping their seed packets. Occasional herbivory (entire fruits or sporadic nibbles) of dehiscent fruits suggests that larger vertebrates, such as bats or locally abundant marsupials, may also be important dispersers, but we have never made direct observations.

Seedling emergence is distinctly seasonal. Most seedlings surface in May, coinciding with the initiation of the dry season. However, seedlings are extremely rare and most reproduction is through vegetative propagation. The vine is extremely clonal and vigorous-growing; monthly growth rates often exceed one meter. Frequent disturbances due to falling palm fronds often topple vines fragmenting them in the process. Fragmented sections readily sprout vegetative buds and in this manner form locally dense, clonal populations.

This *Vanilla* species demonstrates a degree of myrmecology, especially during bud maturation. Small *Azteca* ant colonies anticipate the production of sugars exuded at the abscission layer of immature buds by building colonies in the small, circular depressions housing the axillary meristems.

4. **Vanilla cristato-callosa** Hoehne (**Fig. 2d**).

Plant an understory vine climbing to 4 m. Stems succulent, ca. 0.6–0.9 cm in diameter, internodes ca. 6 cm long for climbing individuals, rarely branched. Aerial roots produced from each node, white, unbranched. Terrestrial roots emerging from lower nodes and entering superficially into substrate, branched and extensive underground. Leaves alternate, produced from each node opposite to roots, distichous, held horizontal to ground, succulent, sessile; blade obovate to elliptic, ca. 3–7 cm wide and 9.5–17 cm long, color often green-yellow when fresh, texture smooth, apex cuspidate, margin entire. Inflorescences terminal or axillary, racemose, fleshy, green, sessile, ca. 1 to 40-flowered; bracts triangular, ca. 0.5 cm long, green; pedicel ca. 0.4 cm wide and 4.9 cm long, white for half its length and fading to green apically. Flowers resupinate, tender, fleshy, arranged spirally, fragrance "fabaceous" (like torn leaf of a bean); buds green; sepals oblanceolate, ca. 0.9 × 6.3 cm, yellow, apex acute; petals oblanceolate, ca. 0.8 × 5.6 cm, yellow, apex acute; lip narrowly tubular when fresh, ca. 5.5 cm long, fused with column for 4 cm dorsally, yellow, flabellate when flattened, unguiculate, the claw a patch of papillae-like projections ca. 0.6 × 1 cm dominating ventral surface near opening; callus penicillate, distinct, ca. 0.4 × 0.3 cm, yellow laciniate scales; column sinusoidal, 4.6 cm long, 0.2 cm wide; anther ca. 0.2 × 0.4 cm, yellow. Fruit dehiscent, cylindric in cross-section, ca. 1 × 15 cm, green and brittle when immature, splitting valves turning brown, leathery, oil rich, often producing abundant gelatinous substance as it opens, with strong vanillin fragrance.

Notes.—An obscure and little known complex, probably synonymous with *V. cristagallii* Hoehne, the main difference apparently in flower size (Soto-Arenas & Cribb 2010). Hoehne proposed several names, but the drawings and type specimens are not useful (Soto Arenas, pers. comm.). These represent a diverse group of poorly collected Amazonian species and field work is necessary to resolve species concepts. Soto-Arenas and Cribb (2010) place it within subgenus *Xanata*, section *Xanata*.

Habitat and Distribution.—Only two fertile collections possessing flowers are known and they are both from the Peruvian Amazon (Soto Arenas, pers. comm.). In our region *V. cristato-callosa* occurs in *M. flexuosa* wetlands characterized by deep histosols where it exhibits a patchy distribution, occurring in small populations within localized areas. Generally, the species is more tolerant of lower light conditions than other local *Vanilla* species.

Natural History.—Flowering occurs in mid-January to April, during the height of the rainy season. In agricultural settings where resource limitations are reduced the flowering season is greatly extended several months. In this case, the terminal racemes prevent upward growth and the vine remains vertically stunted. Ephemeral flowers open singly over an interval of two to four days. Pollination rates are approximately 6% (Table 1). The pollinator is unknown.

Fruits of reproductive individuals in their natural habitat often occupy a terminal position on the inflorescence, suggesting that once pollinated, continued flower production ceases. Fruits mature in approximately six months. Green, brittle fruits turn pliable and oily during dehiscence, a transformation that begins at the tips of newly separated valves and progressively moves upward. In this species a gelatinous substance is sometimes present at the confluence of the valves as they separate. Dehiscent fruits are oily with a strong vanilla aroma, somewhat spicy and cinnamon-like. On several accounts we observed a few individuals of a single species of metallic green *Euglossa sp.* visiting old, completely opened fruits and demonstrating typical fragrance collection behavior (Roubik 1989). The species exhibits a degree of myrmecology, as ants that feed on a sugary exudates secreted at the abscission line between bud and ovary are often present during bud and raceme development.

5. **Vanilla bicolor** Lindl. (**Fig. 2e**).

Plant a vining epiphytic herb in crowns of *Mauritia flexuosa*. Stems thin, ca. 0.4 cm in diameter, green; internodes 8.5–10.5 cm long. Aerial roots produced from each node, attached to host, thin, ca. 3–100 cm in length, sometimes few-branched at apical end, tannish in color. Leaves alternate, produced from each node opposite to roots, distichous, drooping from long petioles; petiole slightly caniculate, ca. 1 cm long, dark red-brown; leaf blade elliptic to slightly ovate, ca. 2.5–4.5 cm wide and 5–11 cm long, discolorous, with pale-green central area and pale red-brown outline along margins, succulent, texture smooth, apex acute, margin entire. Inflorescences axillary and terminal, racemose, fleshy, green, sessile, one to 20 per individual, ca. 1 to 10-flowered; bracts cymbiform, ca. 0.3 cm wide and 0.6 cm long, color red-brown, non-floriferous bracts generally two; pedicel ca. 3 cm long and 0.2 cm in diameter, dark red when young, maturing to green. Flowers resupinate, fleshy, tender, 10 cm across, arranged spirally on raceme, non-fragrant, remaining attached to ovary if successfully pollinated; buds deep red-brown; dorsal sepal oblanceolate, ca. 0.7 × 7.5 cm, orange-brown; lateral sepals oblanceolate, ca. 0.9 × 7.5 cm, orange-brown; petals oblanceolate-linear, ca. 0.6 × 6.5 cm, very pale orange-brown; lip trumpet-like when fresh, fused with column for three quarters of its length, exterior ringed white around mouth fading to yellowish-orange towards interior, margins entire, flabellate and almost triangular when flattened, unguiculate, the claw of soft, yellow tomentose-papillose hairs near apex merging with short yellow pubescence in interior and callus; callus diffuse, ca. 0.7 × 0.3 cm, with thick yellow tomentose; column straight, ca. 4.2 cm long and 0.2 cm wide, ventral surface with lanuginous-hirsute hairs for about a third of its length distally, then glabrous; rostellum extremely thin, narrow, pale white; anther ca. 0.3 × 0.4 cm. Fruit dehiscent, cylindric, ca. 10 cm long, when immature brittle and brownish red or green, splits longitudinally along sutures, splitting valves turning black, pliable, leathery, revealing seeds embedded in a scarcely oily mesocarp, non-fragrant.

Notes.—*Vanilla bicolor* has been generally known by its later synonym, *V. wrightii* Rchb. F. (Christenson 1995). It differs from all other American *Vanilla* (except for the membranaceous group [*V. guianensis*]), in that the penicillate callus is not compact, but rather diffuse. Soto-Arenas and Cribb (2010) placed it in subgenus *Xanata* section *Xanata*.

Distribution and Habitat.—This species has a wide distribution, previously being collected in Cuba, Ecuador, British Guyana, and Venezuela (Soto-Arenas & Cribb 2010). This is the first documentation of *V. bicolor* in Peru, significantly extending its range to the south. In our region it is a common epiphyte of *Mauritia flexuosa*. Long, slender roots reach deep into the slender pocket formed between the sheathing petiole bases of palm fronds and the trunk. It is largely restricted to specific wetland habitat characterized by deep histosols and acidic waters. The species is occasionally encountered as a short terrestrial vine in very open areas with high insolation. These uncommon individuals reach maximum heights of 3 to 4 m well below canopy level and never gain epiphytic status in *M. flexousa* crowns. Terrestrially rooted individuals likely result from the clonal propagation of fallen epiphytes rather than seedling germination and represent the exception, rather than the rule, thus we maintain its classification as a true epiphyte, at least in our region. That said, at Kaieteur National Park, Guyana, the species is known to scramble across rocks at ground surface.

Natural History.—The flowers of *V. bicolor* are non-fragrant, open singly at approximately five-day intervals, and last less than 24 hours. Flowering phenology is fairly aseasonal. We have observed flowers during all 12 months of the year, although there seems to be a slight peak in August during the height of the dry season.

Pollination rates are extremely high, falling within the range of 45 to 75% (Table 1). No local pollinators have been observed at or near flowers and bagging experiments suggest that the plant is self-pollinating. Self-pollination seems to be achieved by the secretion of excess stigmatic fluids that creates a mixture of moisture and pollen grains. The rather thin, narrow rostellum is an ineffective barrier between the pollen-fluid mixture and the stigmatic surface, greatly facilitating self-pollination through excessive stigmatic leak.

Fruiting phenology is aseasonal. Mature fruits, which are quick-drying and non-oily, can be observed throughout the year. The thin, leathery capsule opens from below over the course of several days. The splitting halves turn black as they dry, however they remain pliable for some time. Seeds are not held in a particularly oily matrix as in other fragrant species. The mechanism of seed dispersal of *V. bicolor* is unknown. Lack of fragrance, oils, or sugars, presence of extremely small seeds, and its canopy habitat are all suggestive of dispersal by a mixture of wind turbulence and gravity. As the fruits dehisce and dry, the seeds are exposed to strong winds and then fall downward. Seedlings are abundant, germinating almost exclusively in the small openings between palm trunks and the sheathing petiole bases of palm fronds. This species is not easily propagated vegetatively in artificial settings.

6. **Vanilla palmarum** Lindl. (**Fig. 2f**).

Obligate epiphyte on *Mauritia flexuosa*. Stems succulent, ca. 0.5 cm in diameter, green, internodes 5–6 cm for climbing individuals, one to many-branched. When reproductive often forming a long shoot with slightly diminishing leaf size and internode length. Aerial roots produced from each node, either short (less than 2 cm) and cup-like on reproductive shoots or long and thin on vegetative shoots. Leaves alternate, produced from each node opposite to roots, distichous, sessile, succulent; blade elliptic to ovate, ca. 3.2–6 cm wide and 7–16 cm long, color light green, texture smooth, apex acute to acuminate, margin entire. Inflorescences mostly terminal, racemose, fleshy, green, ca. 5 to 15-flowered; bracts either foliaceous or cymbiform; foliaceous bracts located at inflorescence base, elliptic, ca. 3 cm long, apex acute, generally two, occasionally non-floriferous; cymbiform bracts above, ca. 0.5 cm long, green, always floriferous; pedicel green, but somewhat whitish at extreme base. Flowers resupinate, tender, fleshy, arranged spirally, flowers lightly fragrant, remaining attached to ovary if successfully pollinated; buds green; dorsal sepal elliptic, ca. 1.2 × 6 cm, yellow, apex acute; lateral sepals slightly falcate with bend beginning 2.5 cm from base, ca. 1.3 × 5.6 cm, yellow; petals elliptic, ca. 1.6 × 5.5 cm, yellow, apex acute, longitudinally ribbed on dorsal surface; lip largely pentagonal when flattened, uniformly yellow, unguiculate, the claw of 6–7 longitudinal ridges formed by conspicuous swollen tissues, margins undulate; callus absent; column slightly convex, ca. 4 cm long and 0.25 cm wide, hirsute on ventral surface near rostellum; rostellum somewhat thick, yellow. Fruit dehiscent, triangular in cross-section, green and brittle when immature, ca. 12 cm long, splitting longitudinally in two unequal valves at maturity, valves turning dark brown, pliable, leathery, revealing seeds embedded in a scarcely-oily mesocarp, non fragrant.

Notes.—Vanilla palmarum belongs to subgenus *Xanata*, section *Xanata*. It differs from all other species within the group in lacking a penicillate callus (Soto-Arenas & Cribb 2010).

Habitat and Distribution.—Vanilla palmarum is widespread in Madre de Dios, occurring in the small but ubiquitous *Mauritia flexuosa*-dominated wetlands characterized by hydromorphic substrates with a high mineral component. The species has been observed in wide (approximately 200 m) spring-fed streams with sandy bottoms, on unconsolidated clays on the edges of sping-fed blackwater lakes, and in rain-fed depressions on gleysols. In all *cases M. flexuosa* was monodominant. Similar to *V. bicolor*, the vining herbs are epiphytic in *M. flexuosa* crowns, sending long, slender, branched roots deep into the sheathing petioles. Although restricted to the same host, *V. palmarum* and *V. bicolor* never occur in mixed populations, the latter restricted to *M. flexousa* wetlands with thick, accumulated organic material.

This species is also known from the Guianas where it also grows in the crowns of *Mauritia flexuosa*. It is also reported to occur commonly in northeastern Brazil and in Mato Grosso, Brazil, where is grows on *Syagrus coronata* (Arecaceae), a common arborescent palm of drier '*cerrado*' formations (Toscano de Brito, pers. comm.). Other possible hosts include species of the palm genera *Orbigyna*, *Attalea*, and *Scheelea* (Soto-Arenas & Cribb 2010).

Natural History.—Flowers open singly on the racemes at intervals of three to four days. Flowering phenology is bimodal, with peaks in January to February and October to November. The flowers are slightly fragrant but no potential pollinators have been observed near flowers. Pollination rates are high at 76%, apparently resulting from self-pollination (Table 1). Despite a seemingly more effective barrier provided by the thick rostellum, the mechanism of self-pollination seems to be identical to that of *V. bicolor*. Excessive stigmatic fluids induce pollen grains to leak onto the extreme lateral margins of the stigmatic surface. Pollination rates of flowers located basally on racemes are significantly higher than flowers located apically. This may indicate a degree of control of the self-pollination mechanism, perhaps induced by high resource requirements of fruit maturation and mediated by the allocation of limited resources to competing vegetative and reproductive needs (Chiariello & Gulman 1991). The fruits are non-fragrant and dehisce over the course of several days. Although significantly thicker than *V. bicolor* the fruit mesocarp is not particularly oily and the two valves rapidly dry within weeks, turning leathery. Seedlings are abundant in the canopies of *M. flexuosa* palms as in *V. bicolor*. Reproductive adults high in the canopy probably seed the very specialized germination microsites through combination of wind turbulence and gravity.

DISCUSSION

Wetlands and *Vanilla*

This work represents the accumulation of about seven years of data from field investigations of *Vanilla* orchids in the wetlands of Madre de Dios. Early in our investigations we directed our attention to wetland habitat as *Vanilla* showed distinct preferences for hydromorphic conditions. In the area, the genus generally occurs in association with *Mauritia flexuosa*, or the "*aguaje*" palm as it is known locally in Peru. The palm is indicative of hydromorphic soils in topographical depressions and often forms monodominant stands, or "*aguajales*" (Kahn 1988). Substrates, vegetation structure, and flora vary according to water source and hydrological parameters, but all *M. flexuosa* formations are characterized by: (1) very low sediment loads during relatively brief periods of inundation, (2) relatively minor water level flucuations (less than 50 cm), and (3) low canopies with greater light penetration into the subcanopy (Kahn et al. 1993). Relatively higher insolation and stable hydrological parameters favor the establishment of vining *Vanilla* species, which have precarious seedling stages in the understory and, as adults, superficial root systems vulnerable to prolonged flooding. Under these conditions *Vanilla* often occurs in dense populations and is one of the most conspicuous elements of wetland vegetation. For example, in a related study concerning the distribution patterns of *Vanilla* in regional wetlands, approximately 60% of points placed systematically throughout 70 km of line transect in 28 wetlands, contained at least one species of *Vanilla*, although up to four species occurred at the same point within a 30 m radius. *Vanilla pompona* subsp. *grandiflora* alone was present in over 40% of points and has population densities exceeding 250 individual ramets per hectare (Householder, unpublished data).

While we have collected over 50 species of orchid associated with *Maurita* wetlands, surprisingly few other orchid taxa are found on *M. flexuosa* trunks, probably the result of the challenges of frequent disturbances created by falling palm fronds, slow growth of epiphytic orchids (Zotz 1995), and lack of suitable germination sites on the bare, smooth *Mauritia* trunks (Nieder et al. 2000). Within the Orchidaceae, the vining habit is unique to the genus *Vanilla* (Dressler 1993), and the habit's role in palm-dominated wetlands is noteworthy. All of the epiphytes are obligate to *M. flexousa* and their vining habit allows individuals to maintain their canopy positions by occupying new fronds as senescing ones are sloughed. Unlike the epiphytes, *Vanilla* climbers are not restricted to *Mauritia* hosts, however the palm's shear dominance does make it their most common phorophyte. Climbing vines with terrestrial roots are able to maintain or quickly regain their elevated positions in the canopy after frequent disturbances caused by falling fronds. This level of adaptability may be extremely important in a constantly changing environment, especially if seed germination is limited (Price & Marshall 1999). In short, the success of *Vanilla* in *Mauritia*-dominated wetlands is likely a reflection of the shared ecological inclinations of both palm and orchid and the peculiar growth form of the orchid that provides resilience under a constant disturbance regime.

Fragrance and Bees Interactions

Three of the six *Vanilla* species of Madre de Dios possess pleasantly fragrant fruits. The fragrant condition is associated with succulent fruits with an oil-rich mesocarp and frequent visits by fragrance-collecting Euglossine bees. Hanging fruits slowly split into two separating valves over the course of days to weeks, depending on the species and environmental conditions (fruits in full sun seem to split faster). The splitting valves turn pliable and dark brown to black in color. The opening of the suture is usually preceded by a noticeable band of yellow discoloration that moves upwards as the valves separate. The intensity of fruit fragrance during dehiscence, even on the same fruit, is quite variable from day to day suggesting that the complex enzymatic reaction responsible for producing fruit fragrance may be in part environmentally influenced. The separate valves can remain pliable and moist for months due to abundant oils, turning progressively leathery as they dry out on the vine.

The dispersal mechanism(s) of *Vanilla* remains enigmatic; however several authors have suggested Euglossine bees or bats as potential dispersers (Madison 1981, Soto-Arenas 2003, Lubinsky et. al 2006). We observed *Trigona*, and possibly Euglossine bees, to form sticky seed packets which they often fly away with. Euglossine bees are well-known scent collectors; however the *Trigona* bees may have been more interested in the nutritional value of the oils. Herbivory, possibly due to vertebrate mammals, seems to be extremely rare. That said, the seeds are easily rubbed off and are extremely sticky due to a thin covering of oil. This covering may aid in epizoochorous forms of seed dispersal by any visitor, insect or vertebrate.

The adaptive value and evolutionary significance of fruit fragrance remain unexplored. Fruit fragrance, associated with an oily mesocarp, is a common trait amongst New World *Vanilla* (Soto-Arenas 2003) and it was clearly the main attractant for the Euglossine bee visitors. However, we were surprised by the apparent specificity of bees to fruits. Vanillin, one of the most important aromatics in the commercialization of *Vanilla* fruit, is a general attractant to dozens of Euglossine species in southeastern Peru (Pearson and Dressler 1985). Thus, the few species of bees lured to fragrant fruits of *V. pompona* subsp. *grandiflora* and *V. cristato-callosa* suggests that it is the less abundant aromatics or modifiers other than, or in combination with, vanillin that may be responsible for the observed specificity (Hills et al. 1972). Such phenomena have been well documented in orchid flowers pollinated by Euglossine bees (Adams 1966; Gerlach 2010) where specific pollinator relationships, floral fragrance, and reproductive success are clearly linked (Dodson 1962; van der Pijl & Dodson 1966; Dodson et al. 1969; Hills et al. 1972). However, links between disperser specificity and reproductive success are less clear, at least in *Vanilla*. Curiously, in the case of *V. pompona* subsp. *grandiflora*, both flowers and fruits seem to attract the same Euglossine species, presumably due to the presence of similar aromatic compounds. The potential parallels between flower and fruit fragrance raise intriguing questions concerning the possible role of pollinator interactions in evolution of fruit fragrance of *Vanilla*. Thus, while we suspect that seed dispersal by bees (Madison 1981; Lubinsky et al. 2006), bats, or other animals is entirely possible, and that fragrance may indeed play an important role, we are unsure of the role that these disperser relationships may have played in the evolution of fruit fragrance.

Vanilla bicolor is expected to have fragrant fruits (Soto-Arenas et al. 2003). However, the relatively dry, non-oily fruits are odorless. The lack of fragrance is curious given its basal position within the clade of fragrant *Vanilla* (Soto-Arenas et al. 2003). Lubinsky (2006) and Dressler (1989) suggest that succulent, possibly fragrant fruits may be the ancestral condition in the genus. Madison (1981) suggests that a transition from bee dispersal (possibly associated with fruit fragrance) to wind dispersal (non-fragrant), would be a simple evolutionary step within the family. In any case, the evolution of fruit fragrance within the genus would be much enlightened by mapping its occurrence or disappearance on a phylogeny. However, neither detailed information concerning natural history nor a complete phylogeny of the genus exists.

Distribution Patterns

Vanilla is often considered to be a genus of habitat specialists, often restricted to small geographic ranges and high levels of endemism (Soto-Arenas et al. 2003). Dispersal mechanism(s) remain enigmatic, but *Vanilla* is notable for its smooth, crustose seeds with a well-developed endosperm (Garay 1986). These traits are highly atypical of the family with the majority of the 20,000–30,000 species possessing tiny, dust-like, highly corrugated seeds with little or no endosperm neatly adapted for wind dispersal (Dahlgren and Clifford 1983). Several authors, using evidence from observational (Madison 1981), morphological (Cameron and Chase 1998), and molecular (Nielsen and Siegismund 1999) studies, suggest that *Vanilla* is efficiently dispersed by animals only at local, narrow scales. This is consistent with our current understanding of endemism and restricted distribution patterns of neotropical *Vanilla* species (Soto-Arenas et al. 2003).

With this in mind, the extensive distributional ranges of our Amazonian *Vanilla* seem atypical. For example, *Vanilla bicolor* has previously only been collected in northern South America (Venezuela, Guyana, Ecuador) and the extensive populations discovered in southern Peru are highly disjunct. *Vanilla palmarum* has a similar disjunct distribution, known from Mato Grosso, French Guyana, and now southern Peru. Either these widespread species have more effective long-distance dispersal mechanisms than imagined, or their previously continuous ranges have been fragmented by vicariance events in the geological past. In the latter case, the apparent association between Amazonian *Vanilla* and hydromorphic conditions is intriguing in light of palynological (Rull 1998; Hoorn 2006) and paleogeographical (Hoorn 1993; Hoorn 1994) studies suggesting that semi-aquatic environments of lakes and *Mauritia*-dominated swamps were extensive during the deposition of the upper Pebas Formation in the early-mid Miocene. Indeed, an ancient, extensive wetland system covering over one million km^2, in the heart of the modern Amazon basin (Wesselingh et al. 2002) would have been a cradle of speciation for wetland-associated organisms and a means of range expansion for others (i.e., *Vanilla*). With Andean orogeny and the formation of the modern Amazon River, many wetland-associated organisms may have become progressively isolated and fragmented, pushed to the peripheries of their original distributions displaced by the highly pulsating, highly depositional environment that characterizes most Amazonian rivers. The extent to which this has influenced current species distribution, evolution, and diversity of Amazonian *Vanilla*, however, is limited to conjecture, especially without molecular evidence.

Conservation

Our studies of the flora of the wetlands of Madre de Dios has led to the documentation of nearly 600 species of plants that are largely restricted to those ecosystems. This includes more than 50 species of orchids—up to half of the orchid species diversity currently known for Madre de Dios. The dearth of collection history of Amazonian *Vanilla* is lamentable, limiting our understanding of the evolution and diversification of the genus. We believe this state of affairs typifies our current understanding of the larger Amazonian flora, and especially of the ubiquitous, but little-studied wetlands occupied by Amazonian *Vanilla*. This deficit is especially alarming given the increasing rate of human development and habitat destruction in and around upper Amazonian wetlands. In Madre de Dios, gold mining directly within wetlands is an immediate threat to the flora, fauna, and the important ecosystem services provided by these understudied and largely unprotected wetlands. Furthermore, proposals to construct a $4 billion dam in the Inambari River watershed (a tributary of the Madre de Dios River), the largest in Peru and the fifth largest in Latin America, would especially degrade regional wetland ecosystems (Barrow 1988; Dourojeanni 2009). Despite the high diversity and abundance within wetlands, the extensive *Vanilla* populations of the western Amazon have never been documented by the scientific community and are virtually unknown to local peoples. Its high visibility and abundance make it an interesting model for future ecological and molecular studies. Additionally, fruit fragrance of several species makes them good candidates as gene donors for the improvement of existing *Vanilla* cultivars or the adoption of alternative ones. Given the importance of *Vanilla* as a globally-traded agricultural product and the precarious status in which many populations exist worldwide, we urgently encourage protection and continued studies of *Vanilla*-rich Amazonian wetland habitats in Madre de Dios, Peru, as an important reservoir of genetic material.

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BOOK REVIEW

BRIAN LOFLIN AND SHIRLEY LOFLIN. 2009. **Texas Cacti: A Field Guide.** (ISBN 978-1-60344-108-7, flexbound with flaps). Texas A&M University Press, John H. Lindsey Building, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911). $24.00, 312 pp., 483 color photos, 103 maps, 5 3/4" × 9".

Though it seems that cacti are sometimes overlooked in the world of plants, this book does an excellent job of sparking interest through high-quality images on nearly every page. Breaking down the broad spectrum of cacti by region, each specimen is awarded its own full page loaded with information. With detailed specimen notes on location, spine characteristics, individual features, habitat, and flowering season, *Texas Cacti* is a must-have guide for anyone in need of a comprehensive handbook on the subject.—*Haden Shibley, Volunteer, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

From the publisher: "In *Texas Cacti*, authors Brian and Shirley Loflin present a concise, fully illustrated field guide to more than one hundred of the cacti most often found in Texas and the surrounding region. The book opens with an illustrated introduction to cactus habitat and anatomy. The species are then organized by stem shape, with each account featuring detailed color photographs, specific identifying features (including spines, flowers, fruits, and seeds) and information about common and scientific names, habitat, flowering season, and more. The photographs, range maps, and icons designating shape, conservation status, and blooming period, along with easy-to-understand descriptions, make this book a quick and friendly guide to cactus identification for botanists, amateur naturalists, and cactus enthusiasts alike."

"**Brian** and **Shirley Loflin** are independent writers and photographers living in Austin. Authors of *Grasses of the Texas Hill Country*, the Loflins also teach nature photography workshops in a variety of venues. Their photographs have appeared in many books and periodicals, including *Texas Parks and Wildlife, Outdoor Photographer,* and *Texas Highways.*"

PHYLOGENETIC ANALYSES OF THE *GAYLUSSACIA FRONDOSA* COMPLEX (ERICACEAE: VACCINIEAE) BASED ON MOLECULAR AND MORPHOLOGICAL CHARACTERS

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ABSTRACT

The three closely related species of blue huckleberries, i.e., *Gaylussacia frondosa*, *G. tomentosa*, and *G. nana*, which make up the *Gaylussacia frondosa* complex (sect. *Decamerium*, subsect. *Frondosae*), have been variously circumscribed and classified by North American systematists. This study aims to resolve the species relationships of the *Gaylussacia frondosa* complex through phylogenetic analyses of morphological characters and nuclear ribosomal internal transcribed spacer (nrITS) sequences. *Gaylussacia nana* forms a distinct clade with support in all analyses. Contrary to some earlier treatments, our results strongly support distinguishing *G. nana* from *G. tomentosa*, although a few putative hybrids between these species were discovered. The monophyly of *G. tomentosa* is not strongly supported, but is upheld in the morphology-based analysis and the combined (nrITS + morphology) analysis, and a *G. frondosa* + *G. tomentosa* clade is strongly supported in the nrITS and combined analyses. In contrast, the morphological topology groups *G. frondosa* with *G. nana*. None of the analyses support a *G. frondosa* clade, but the specimens representing *G. frondosa* do form a clade in some of the most parsimonious trees in the combined analysis, while in others they constitute a paraphyletic complex (in a clade with *G. tomentosa*). Chromosome counts by previous workers indicate that *G. tomentosa* is tetraploid, whereas *G. frondosa* and *G. nana* are diploid. *Gaylussacia frondosa* (in contrast to *G. tomentosa* and *G. nana*) tends to be a taller plant and has a more northern distribution. Based on this evidence, we suggest that all three taxa be considered distinct species (each likely representing a separate evolutionary lineage).

Key Words: *Gaylussacia frondosa, G. tomentosa, G. nana, Ericaceae, Gaylussacia sect. Decamerium*

RESUMEN

Las tres especies íntimamente relacionadas de arandaneras, i.e., *Gaylussacia frondosa*, *G. tomentosa*, y *G. nana*, que constituyen el complejo *Gaylussacia frondosa* (sect. *Decamerium*, subsect. *Frondosae*), han sido circunscritas y clasificadas variadamente por los sistemáticos norteamericanos. Este estudio trata de resolver las relaciones entre las especies del complejo *Gaylussacia frondosa* mediante análisis filogenéticos de caracteres morfológicos y secuencias del espaciador nuclear ribosómico interno (nrITS). *Gaylussacia nana* forma un clado distinto con soporte en todos los análisis. Contrariamente a algunos tratamientos previos, nuestros resultados soportan fuertemente la distinción entre *G. nana* y *G. tomentosa*, aunque se encontraron algunos híbridos putativos entre estas especies. La monofilia de *G. tomentosa* no está fuertemente soportada, sino que está apoyada en el análisis morfológico y el combinado (nrITS + morfología), y un clado *G. frondosa* + *G. tomentosa* está fuertemente soportado en los análisis de nrITS y los combinados. En contraste, la topología morfológica agrupa *G. frondosa* con *G. nana*. Ninguno de los análisis soporta un clado de *G. frondosa*, pero los especimenes que representan *G. frondosa* forma un clado en alguno de los árboles más parsimoniosos del análisis combinado, mientras que en otros constituye en complejo parafilético (en un clado con *G. tomentosa*). Los recuentos cromosomáticos realizados por investigadores anteriores indican que *G. tomentosa* es tetraploide, mientras que *G. frondosa* y *G. nana* son diploides. *Gaylussacia frondosa* (en contraste con *G. tomentosa* y *G. nana*) tiende a ser una planta más alta y tiene una distribución más septentrional. Basados en estas pruebas, sugerimos que los tres taxa sean considerados especies distintas (cada una representando probablemente una línea evolutiva separada).

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Gaylussacia Kunth is a New World genus of 53 species of mainly understory shrubs occurring in mesic to xeric woodlands and shrublands, as well as acidic bogs. The genus is differentiated from the closely-related *Vaccinium* L. by ten-locular ovaries, drupaceous fruits containing ten pits, the presence of resin glands on the leaves (except for *G. brachycera* (Michx.) A. Gray), and the lack of staminal spurs (Duncan & Brittain 1966; Luteyn et al. 1996; Palser 1961; Wood 1961). However, the phylogenetic relationships between members of the two genera are still uncertain (Kron et al. 2002b). *Vaccinium* was shown to be non-monophyletic as traditionally circumscribed, with *Gaylussacia* nested within it (Kron et al. 2002a). These results are corroborated by the ambiguous generic identity of *G. brachycera*, which, in addition to being eglandular and similar in form to *Vaccinium* species, has been shown to be sister to the rest of *Gaylussacia* (Floyd 2002). Finally, some *Vaccinium* species have ovaries that are pseudo-10-locular and, therefore, resemble the 10-locular ovaries of *Gaylussacia* (Vander Kloet & Dickinson 1992).

Gaylussacia usually has been divided into three sections (following Sleumer 1967): section *Vitis-idaea* Drude (only *G. brachycera*), section *Gaylussacia* (ca. 47 species, mainly South American; plants mostly evergreen, with stalked glands on the leaves), and the North American section *Decamerium* Torr. & A. Gray (ca. five species; plants deciduous, with sessile glands on the leaves). The last is the focus of this study. All three sections are represented in eastern North America: *G. brachycera*, four of the species of section *Gaylussacia* (*G. mosieri* Small, *G. dumosa* (Andr.) A. Gray, *G. orocola* (Small) Camp, *G. bigeloviana* (Fernald) Sorrie & Weakley; see Sorrie & Weakley, 2007, although the latter two entities are often included within an expanded *G. dumosa*), and all five species of section *Decamerium* [*G. frondosa* (L.) Torr. & A. Gray, *G. tomentosa* (A. Gray) Pursh ex Small, *G. nana* (A. Gray) Small, *G. ursina* (Curtis) Torr. & A. Gray, and *G. baccata* (Wang.) K. Koch]. For more information on the history and systematics of these groups see Camp (1935), Wood (1961), Luteyn et al. (1996), Floyd (2002), and Sorrie and Weakley (2007).

A phylogenetic analysis of *Gaylussacia* had not been carried out prior to that of Floyd (2002). In her morphology-based analysis, which included most of the species of the genus, the monophyly of sects. *Decamerium* and (of course) *Vitis-idaea* were supported, but sect. *Gaylussacia* was paraphyletic. All three traditional sectional divisions were weakly to moderately supported by cpDNA (*trnL-trnF*) data, as well as in analyses combining morphological and molecular data, but nrITS sequences alone did not support the monophyly of either sect. *Decamerium* or sect. *Gaylussacia*. Molecular data were lacking for most species of sect. *Gaylussacia* and relationships within this large clade remain poorly understood. Floyd's (2002) analysis also did not clarify the placement of *G. brachycera*; neither did it fully clarify species delimitations and relationships within sect. *Decamerium*.

Camp (1941) recognized three subsections within sect. *Decamerium*, two of which, subsects. *Baccatae* and *Ursinae*, are monotypic, i.e., *Gaylussacia baccata* and *G. ursina*, respectively. The remaining three taxa, i.e., *G. frondosa*, *G. tomentosa* and *G. nana*, were placed in his subsection *Frondosae*. The taxa within the *Frondosae* group have had a confusing taxonomic history and have been variously circumscribed. Elliott (1821) and Chapman (1889) recognized only *G. frondosa*. Radford et al. (1964) recognized only *G. frondosa*, but included two varieties: i.e., *G. frondosa* var. *tomentosa* A. Gray and var. *frondosa*; Wunderlin and Hansen (2003) did the same, recognizing only var. *tomentosa* as occurring in Florida. Gray (1878) was the first author to recognize *G. frondosa* var. *tomentosa*, and he also recognized *G. frondosa* var. *nana* A. Gray. Harper (1906) treated the members of subsect. *Frondosae* as a single species with three varieties, i.e., *G. frondosa* var. *frondosa*, var. *tomentosa*, and var. *nana*. Sleumer (1967) also treated the subsection as a single species, but recognized *G. frondosa* var. *polycodioides* Camp and f. *glaucophylla* Camp (both pertaining to northern plants usually treated within var. *frondosa*). Small (1897, 1933), Camp (1935, 1941), Wood (1961), Duncan and Brittain (1966), and Luteyn et al. (1996) treated the subsection as three separate species (*G. frondosa*, *G. tomentosa*, and *G. nana*). Most recently, Floyd (2002) treated the subsection as one species with three varieties. However, she suggested that var. *nana* perhaps should be considered a separate species, citing a possible lineage sorting or hybridization event as being responsible for its incongruent placement in her nrITS and cpDNA trees. Yet, as noted by Floyd, such problems could also merely be due to inadequate data, possibly resulting in poor resolution in her cladograms. She recommended more research in order to resolve species limits within the *Frondosae* group.

Field observations (over many years, by W.S. Judd) of the notable and seemingly consistent morphological differences between the sympatric *Gaylussacia tomentosa* and *G. nana* in Florida motivated the present study (Fig. 1). The purpose of this study is to resolve the phylogenetic relationships within this subsection, i.e., the *G. frondosa* complex, by focusing on plants identified as *G. frondosa*, *G. tomentosa* and *G. nana*. We sought to determine appropriate species limits within the *G. frondosa* complex, based on phenetic, evolutionary, diagnostic, and apomorphic species concepts (Davis & Nixon 1992; Donoghue 1985; de Queiroz 2007; Judd et al. 2007; Mishler 1985; Mishler & Theriot 2000; Wheeler & Platnick 2000; Wiley & Mayden 2000).

MATERIALS & METHODS

Taxon sampling and field work.—Voucher material representing the *Gaylussacia frondosa* complex was collected by M.T. Gajdeczka and W.S. Judd from numerous localities in Florida, Georgia, South Carolina, and North Carolina in the spring and summer of 2007 in order to estimate genetic diversity (Table 1; all deposited at FLAS). *Gaylussacia ursina* and *G. baccata* were also collected, and were selected as outgroups based on the traditional classification of section *Decamerium* (Camp 1941) and the recent phylogeny of Floyd (2002). Leaf material for DNA extraction of field-collected specimens was preserved in silica gel. DNAs derived from herbarium collections also were included in the study to supplement the number of evolutionary units in the analyses, especially of *G. frondosa*, as well as outgroup taxa. One collection of *G. dumosa* (of section *Gaylussacia*) was included as a more distant outgroup.

Morphology.—Potentially phylogenetically informative morphological characters were selected after careful consideration of the pattern of variation seen in material at the University of Florida Herbarium of the Florida Museum of Natural History (FLAS), field observations (of M.T. Gajdeczka and W.S. Judd), and previous taxonomic work on the genus (Duncan & Brittain 1966; Luteyn et al. 1996; Floyd 2002). Seventy qualitative and quantitative morphological characters were initially assessed; all above ground organs were examined, including both vegetative and reproductive features, with an emphasis on density, distribution, and form of the hairs (both glandular and non-glandular). From the initial list of characters observed, 20 were selected as potentially phylogenetically informative and were included in the matrix for analysis (see Tables 2, 3).

Unicellular hair presence, density and length and resin gland presence, density and width have been considered especially useful in distinguishing species of *Gaylussacia* (Floyd 2002; Luteyn et al. 1996), and thus these were included in the analyses. Most of the initial hair and gland measurements could be grouped into character-clusters, which showed identical or very similar patterns of variation among taxa. In such cases, a single character (from each group of highly correlated characters) was selected for inclusion in the phylogenetic analyses. However, measurement of the length of the longest hair and average hair length of the adaxial leaf surfaces (chars. #5 and 6; see Table 2) were both included in order to take into account the observed variation in the range of hair length between specimens.

Many morphological characters used in the analyses (Table 2) were readily divisible into discrete states, thus avoiding arbitrary decisions relating to state delimitation (Stevens 1991). However quantitative characters proved more problematic. Variation in these characters (e.g., chars. #1, 3, 6, 7, 8, 11, 12, and 13; see Table 2) was assessed by means of bar graphs, and the states of those included in the analyses were delimited by more or less discrete gaps (e.g., Fig. 2, char. #9). The most problematic characters in terms of state delimitation were non-glandular hair length on the abaxial leaf surface (#8), and the length (#33) and width (#34) of the longest blades; these characters showed nearly continuous distributions, but were included in the analyses because they have been stressed as taxonomically important in the *Gaylussacia frondosa* complex (Duncan & Brittain 1966), and because the overlap in values between taxa was limited. Many characters could not be included in the analyses because they showed too much infraspecific variation or varied continuously

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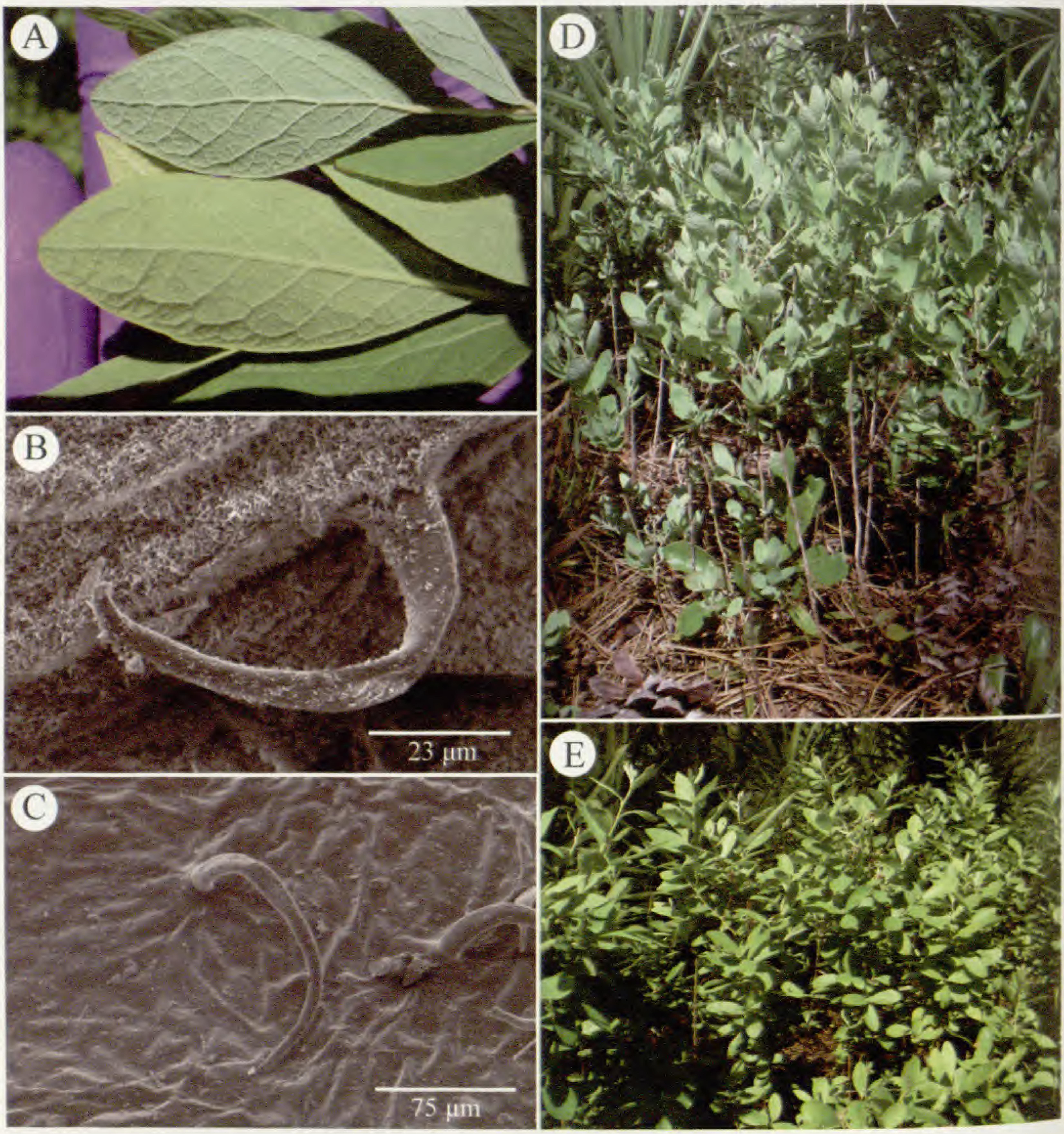

Fig. 1. *Gaylussacia nana* (top of A, B, D) and *G. tomentosa* (bottom of A, C, E). **A.** The glaucousness (gray coloration) of the abaxial leaf surface of *G. nana* compared to *G. tomentosa*. **B&C.** SEM image of glaucous abaxial surface of the leaf of *G. nana* (**B**) and non-glaucous abaxial leaf surface of *G. tomentosa* (**C**). **D.** Habit of *G. nana*. **E.** Habit of *G. tomentosa*. Photographs A, D and E, from Morningside Nature Center, Alachua Co., FL, by W.S. Judd; photographs B and C by G.M. Ionta.

across taxa (and thus could not be delimited into states). Characters not observed for particular species were scored as missing values, as were situations where a character was considered "not applicable" in a particular taxon, and coded as "?" (Table 2).

DNA extraction, amplification and sequencing.—Leaves and flowers dried in silica-gel were used for DNA extraction of field collected material. A modified version of the 2x CTAB procedure (Doyle & Doyle 1987) was used, as described in Whitten et al. (2007) with the addition of proteinase K (5 units) to the extraction buffer instead of 2-mercaptoethanol. Precipitated DNA pellets from extractions of field-collected material were resuspended in 200 µL of Tris-EDTA (TE) buffer. Small fragments of leaf tissue were removed

Table 1. Specimens sampled for the morphological and nrITS analyses. All vouchers deposited at FLAS.

Taxon	Voucher	Collection Location	ITS-GenBank
G. baccata	*A. Vascott 405*	King & Queen Co., VA	NA
G. baccata	*E.W. Wood 4222*	Clinton Co., PA	FJ985237
G. baccata	*W.S. Judd 1657*	Barnstable Co., MA	NA
G. baccata	*W.S. Judd 716*	Norfolk Co., MA	FJ985236
G. baccata	*M. Gajdeczka 50*	Burke Co., NC	FJ985196
G. dumosa	*M. Gajdeczka 18*	Alachua Co., FL	FJ985199
G. frondosa	*A.B. Pittman 05090108*	Orangeburg Co., SC	FJ985228
G. frondosa	*A.B. Pittman 053009303*	Aiken Co., SC	FJ985227
G. frondosa	*G.W. Seckinger, Jr. 271*	Georgetown Co., SC	FJ985226
G. frondosa	*J.B. Nelson 16473*	Richland Co., SC	NA
G. frondosa	*M. Gajdeczka 56*	Colleton Co., SC	FJ985197
G. frondosa	*M. Gajdeczka 57*	Colleton Co., SC	FJ985212
G. frondosa	*R.R. Smith 1563*	Santa Rosa Co., FL	NA
G. frondosa	*W.S. Judd 786*	Norfolk Co., MA	NA
G. nana	*C. van Hoek & B. Wargo 1084*	Polk Co., FL	FJ985225
G. nana	*J. Amoroso 261*	Levy Co., FL	FJ985223
G. nana	*M. Gajdeczka 16*	Alachua Co., FL	FJ985191
G. nana	*M. Gajdeczka 22*	Putnam Co., FL	FJ985202
G. nana	*M. Gajdeczka 23*	Suwannee Co., FL	FJ985203
G. nana	*M. Gajdeczka 31*	Lowndes Co., GA	FJ985206
G. nana	*M. Gajdeczka 38*	Jeff Davis Co., GA	FJ985194
G. nana	*M. Gajdeczka 60*	Alachua Co., FL	FJ985213
G. nana	*M. Gajdeczka 61*	Alachua Co., FL	FJ985214
G. nana	*M. Gajdeczka 64*	Alachua Co., FL	FJ985217
G. nana	*M. Gajdeczka 65*	Alachua Co., FL	FJ985218
G. nana	*M. Gajdeczka 66*	Marion Co., FL	FJ985219
G. nana	*M. Gajdeczka 70*	Sumter Co., FL	FJ985220
G. nana	*R.K. Godfrey 8484583*	Wakulla Co., FL	FJ985222
G. tomentosa	*J.B. Nelson 20500*	Appling Co., GA	FJ985224
G. tomentosa	*B. Tan 698*	Columbia Co., FL	FJ985232
G. tomentosa	*D. Hall 1981*	Clay Co., FL	FJ985231
G. tomentosa	*J.R. Abbott 10463*	Hamilton Co., FL	FJ985234
G. tomentosa	*M. Gajdeczka 17*	Alachua Co., FL	FJ985192
G. tomentosa	*M. Gajdeczka 19*	Putnam Co., FL	FJ985200
G. tomentosa	*M. Gajdeczka 20*	Putnam Co., FL	FJ985201
G. tomentosa × nana	*M. Gajdeczka 21*	Putnam Co., FL	NA
G. tomentosa	*M. Gajdeczka 24*	Suwannee Co., FL	FJ985204
G. tomentosa	*M. Gajdeczka 30*	Lowndes Co., GA	FJ985205
G. tomentosa	*M. Gajdeczka 32*	Lowndes Co., GA	FJ985207
G. tomentosa	*M. Gajdeczka 33*	Lowndes Co., GA	FJ985208
G. tomentosa	*M. Gajdeczka 36*	Coffee Co., GA	FJ985209
G. tomentosa	*M. Gajdeczka 37*	Jeff Davis Co., GA	FJ985193
G. tomentosa × nana	*M. Gajdeczka 43*	Bulloch Co., GA	FJ985210
G. tomentosa	*M. Gajdeczka 58*	Screven Co., GA	FJ985198
G. tomentosa	*M. Gajdeczka 62*	Alachua Co., FL	FJ985215
G. tomentosa	*M. Gajdeczka 63*	Alachua Co., FL	FJ985216
G. tomentosa	*M. Gajdeczka 78*	Marion Co., FL	FJ985221
G. tomentosa	*R.K. Godfrey 83157*	Liberty Co., FL	FJ985230
G. tomentosa	*S. Orzell & E. Bridges 22613*	Lake Co., FL	FJ985233
G. tomentosa	*W.S. Judd 1679*	Beaufort Co., SC	FJ985229
G. ursina	*A. Crooks 526*	Sevier Co., TN	NA
G. ursina	*A. Darr 1909*	Oconee Co., SC	FJ985235
G. ursina	*M. Gajdeczka 47*	Transylvania Co., NC	FJ985195
G. ursina	*M. Gajdeczka 48*	Transylvania Co., NC	FJ985211

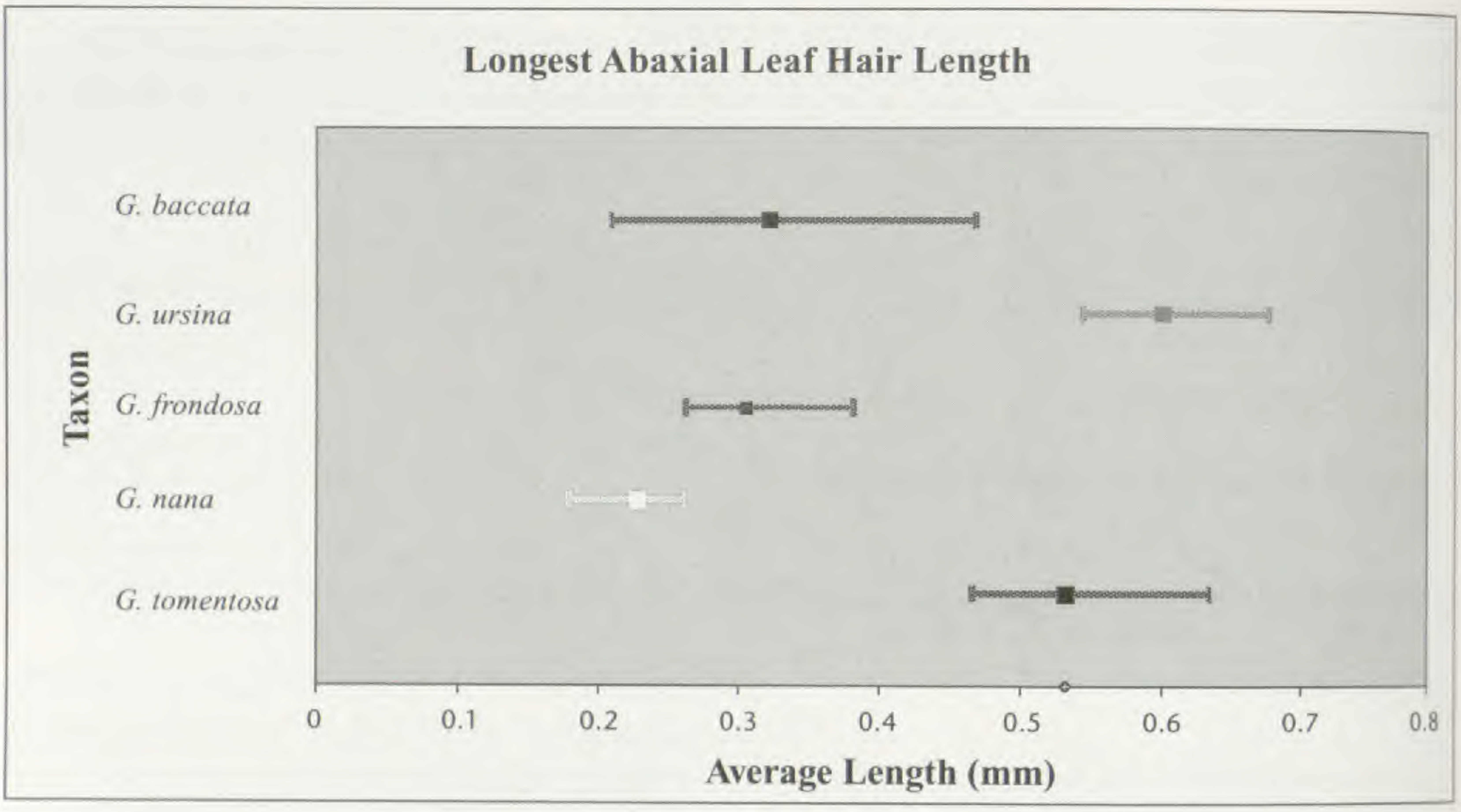

Fig. 2. Graph showing variation in the length of the longest non-glandular hair on the abaxial surface of the leaf for members of *Gaylussacia* sect. *Decamerium*. Squares represent the average of the measurements for all specimens of the corresponding taxon. Lines on either side represent the range of all measurements.

Table 2. Morphological characters and character states included in the phylogenetic analyses of *Gaylussacia*.

1. Plant height: $n < 0.7$ m (0); $n \geq 0.7$ m (1).
2. Ratio of average length of lower secondary branches to length of main stem: $n < 7$ (0); $n \geq 7$ (1).
3. Length of longest non-glandular hair on branch: $n < 0.5$ mm (0); $n \geq 0.5$ mm (1).
4. Number (density) of non-glandular hairs on the adaxial leaf surface per standardized 2.56 mm^2 region: none (0); $0 < n < 10$ (1); $n \geq 10$ (2).
5. Length of longest non-glandular hair on adaxial leaf surface: $0 < n < 0.25$ mm (0); $n \geq 0.25$ mm (1).
6. Length of average non-glandular hair on adaxial leaf surface; $0 < n < 0.175$ mm (0); $0.175 \leq n < 0.322$ mm (1); $n \geq 0.322$ mm (2).
7. Number (density) of non-glandular hairs on the abaxial leaf surface per standardized 1.32 mm^2 region: $0 < n < 6.5$ (0); $6.5 \leq n < 40$ (1); $n \geq 40$ (2).
8. Length of longest non-glandular hair on abaxial leaf surface: $0 < n < 0.275$ mm (0); $0.275 \leq n < 0.45$ mm (1); $n \geq 0.45$ mm (2).
9. Number (density) of resin glands on abaxial leaf surface per standardized 4.0 mm^2 region: $0 < n < 19$ (0); $19 \leq n < 65$ (1); $n \geq 65$ (2).
10. Glaucousness of leaves: none (0); slight (1); moderate (2); strong (3).
11. Length of blade (average of five longest leaves per specimen): $n < 41.1$ mm (0); $41.1 \leq n < 70$ mm (1); $n \geq 70$ mm (2).
12. Width of blade (average of five longest leaves): $n < 20.3$ mm (0); $20.3 \leq n < 30$ mm (1); $n \geq 30$ (2).
13. Petiole length (average of five longest leaves): $n < 1.35$ mm (0); $n \geq 1.35$ mm (1).
14. Bract type: leaf-like (0); small (1; states coded and scored as per Luteyn et al. 1996, and for this character and #16, 17, 18 and 19, our observations, when these were possible, always matched these scorings).
15. Resin glands on adaxial leaf surface: present (0); absent (1).
16. Fruit color: black (0); blue (1; states coded and scored as per Luteyn et al. 1996).
17. Corolla color: white (0); greenish-white to pinkish white (1); red (2; states coded and scored as per Luteyn et al. 1996).
18. Corolla shape: cylindrically urceolate (0); broadly urceolate (1; states coded and scored as per Luteyn et al. 1996).
19. Pilose hairs on the filaments: present (0); absent (1; states coded and scored as per Luteyn et al. 1996).
20. Exudate around perimeter of resin glands on leaves: present (0); absent (1).

Table 3. Morphological character state values for terminal taxa used in the phylogenetic analyses. ? = state unknown or "not applicable." All specimens deposited at FLAS

Specimen	Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
W. S. Judd 1679	*G. tomentosa*	0	0	1	2	1	1	2	2	1	0	0	0	1	1	1	1	1	0	1	1
M. Gajdeczka 17	*G. tomentosa*	1	1	1	2	1	1	1	2	1	0	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 19	*G. tomentosa*	1	1	1	2	1	2	1	2	1	2	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 20	*G. tomentosa*	1	1	?	2	1	2	2	2	1	?	1	0	1	1	1	1	1	0	1	1
M. Gajdeczka 21	*G. tomentosa × nana*	?	1	1	2	1	1	2	2	1	0*	1	0	1	1	1	1	1	0	1	1
M. Gajdeczka 24	*G. tomentosa*	1	1	0	2	1	1	2	2	1	1	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 30	*G. tomentosa*	1	1	1	2	1	1	2	2	1	0	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 32	*G. tomentosa*	1	?	0	2	1	1	2	2	1	0	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 33	*G. tomentosa*	1	?	1	2	1	1	2	2	1	0	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 36	*G. tomentosa*	?	?	1	2	1	1	1	2	1	0	2	1	1	1	1	1	1	0	1	1
M. Gajdeczka 37	*G. tomentosa*	?	0	1	2	1	1	2	2	1	0	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 43	*G. tomentosa x nana*	?	1	0	2	1	1	1	2	0	?	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 58	*G. tomentosa*	1	1	1	2	1	2	2	2	1	1	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 16	*G. nana*	1	1	0	1	0	0	1	0	0	?	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 22	*G. nana*	?	0	0	0	0	0	1	0	0	2	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 23	*G. nana*	0	?	0	1	0	0	1	0	1	3	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 31	*G. nana*	1	0	0	1	0	0	1	0	0	2	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 38	*G. nana*	?	0	0	1	0	0	1	0	0	?	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 60	*G. nana*	0	0	0	1	0	0	1	0	0	2	0	0	0	1	1	1	1	0	1	1
M. Gajdeczka 61	*G. nana*	0	?	0	1	0	0	1	0	1	1	0	0	0	1	1	1	1	0	1	1
R. K. Godfrey 8484583	*G. nana*	0	0	0	1	?	?	1	0	0	3	0	0	0	1	1	1	1	0	1	1
A. B. Pittman 05090108	*G. frondosa*	?	?	0	0	?	1	1	1	1	?	1	1	1	1	1	1	1	0	1	1
G. W. Seckinger Jr. 271	*G. frondosa*	?	0	0	0	?	?	1	0	1	?	0	1	1	1	1	1	1	0	1	1
J. B. Nelson 16,473	*G. frondosa*	?	0	?	0	?	?	1	1	1	?	0	0	1	1	1	1	1	0	1	1
M. Gajdeczka 56	*G. frondosa*	1	0	?	0	?	?	1	1	1	2	1	1	1	1	1	1	1	0	1	1
M. Gajdeczka 57	*G. frondosa*	1	0	0	0	1	1	1	1	1	2	1	1	1	1	1	1	1	0	1	1
W. S. Judd 786	*G. frondosa*	1	0	0	1	?	?	1	1	0	1	1	2	1	1	1	1	1	0	1	1
R. R. Smith 1563	*G. frondosa*	1	?	0	1	1	1	1	1	1	0	2	2	1	1	1	1	1	0	1	1
D. Darr 1909	*G. ursina*	?	?	0	1	1	2	0	2	0	0	2	1	1	1	1	0	1	0	0	1
A. Crooks 526	*G. ursina*	?	1	1	0	1	2	0	?	0	1	2	2	1	1	1	0	1	0	0	1
M. Gajdeczka 47	*G. ursina*	1	1	1	0	1	2	0	2	0	0	2	2	1	1	1	0	1	0	0	1
M. Gajdeczka 48	*G. ursina*	1	?	1	1	1	2	0	2	0	0	2	2	1	1	1	0	1	0	0	1
M. Gajdeczka 50	*G. baccata*	1	?	0	1	1	1	0	0	1	?	1	0	1	1	0	0	2	1	0	0
W. S. Judd 716	*G. baccata*	1	1	0	1	1	1	0	1	2	0	0	0	1	1	0	0	2	1	0	0
E. W. Wood 4222	*G. baccata*	?	1	0	1	1	1	0	1	2	0	1	0	1	1	0	0	2	1	0	0
A. Vascott 405	*G. baccata*	?	0	0	1	1	1	0	1	2	0	1	0	1	1	0	0	2	1	0	0
W. S. Judd 1657	*G. baccata*	1	1	0	1	1	1	0	1	2	0	0	0	0	1	0	0	2	1	0	0
M. Gajdeczka 18	*G. dumosa*	0	1	0	1	1	1	0	?	1	0	0	0	0	0	0	0	0	0	0	0

*Collection number represented by three herbarium sheets, and a few leaves do show slight glaucousness.

from some herbarium specimens for DNA extraction. Anticipating a lower DNA concentration, the herbarium extractions were resuspended in only 120 µL of Tris-EDTA (TE) buffer. In all extractions the resuspended DNA was purified using Qiaquick columns (Qiagen, Valencia, California, USA) and Buffer PE, then eluted with Buffer EB.

All PCR reactions were carried out using Sigma Jumpstart *Taq* polymerase and reagents (Sigma-Aldrich, St. Louis, Missouri, USA). Initially a survey of phylogenetically informative regions were carried out using the nuclear ribosomal nrITS region and seven plastid DNA regions (*trnL-F*, *rpl32-trnL*, *trnQ-rps16*, *trnH-psbA*, *atpB-rbcL*, *psbD-trnT* and *trnV-ndhC*) based on suggestions of phylogenetically useful regions in Small et al.

(1998) and Shaw et al. (2005, 2007). Two representative field-collected specimens of each of the three in-group taxa (*Gaylussacia frondosa*, *G. tomentosa*, and *G. nana*) and one sample each of *G. baccata* and *G. ursina* were included in the survey. The reaction mixture for amplification of nrITS from field collected specimens included 7.0 µL of betaine (5 M), 12 µL H_2O, 2.5 µL 10X buffer, 2.0 µL $MgCl_2$ (25 mM), 0.5 µL dNTPs (10 µM), 0.5 µL of each primer (10 µM), 0.5 µL template, and 0.2 µL *Taq* polymerase (25.5 µL total). In order to improve amplicon concentration, volumes were adjusted to 1.0 µL template and 11.0 µL H_2O (25.7 µL total). Reaction mixtures for the amplifications from herbarium specimens totaled 24.7 µL (18 µL H_2O, 2.5 µL 10X buffer, 2.0 µL $MgCl_2$ (25 mM), 0.5 µL dNTPs (10 µM), 0.5 µL each of forward and reverse primer (10 µM), 0.5 µL template, and 0.2 µL *Taq* polymerase).

The following PCR protocol was used for the initial survey: an initial bake at 94°C for 3 min; then 30 cycles of (1) denaturation at 94°C for 30 s, (2) annealing at 60°C for 30 s, and (3) extension at 72°C for 2 min; and a final extension at 72°C for 3 min. Primers 17SE and 26SE from Sun et al. (1994) and the PCR program in Whitten, et al. (2007) were used for amplification and sequencing of the nrITS region from field collected specimens. With the aim of improving nrITS amplicon yield from herbarium specimens, primers ITS A/ITS C and ITS B/ITS D and the protocol from Blattner (1999) were used, and the reaction mixture was doubled to 50.4 µL (30 µL H_2O, 6 µL $MgCl_2$ (25 mM), 5 µL 10X buffer, 4 µL template 2 µL each of forward and reverse primer (10µM), 1.0 µL dNTPs (10µM), and 0.4 µL Taq polymerase).

Phylogenetic analyses.—Herbarium specimens, based on the first author's own field work or from the collections of FLAS, and representing populations of all the entities within the *Gaylussacia frondosa* complex, were employed as terminal taxa in the phylogenetic analyses. These analyses served as the basis not only of the assessment of phylogenetic relationships within *Gaylussacia* section *Decamerium* but also for hypotheses of species circumscription (based on an application of the phylogenetic/apomorphic species concept; Donoghue 1985; Mishler 1985; Mishler & Theirot 2000).

PAUP* 4.0b10 (Swofford 2002) was used to construct most parsimonious trees for three data sets: (1) a morphological analysis of 38 specimens (i.e., terminal taxa, representing populations; 26 of these field-collected and 12 herbarium/FLAS collections) and 20 characters, and 19 of these parsimony informative (see Table 2), (2) a nrITS analysis of 47 specimens and 827–857bp (31 field-collected specimens) or 648–664 bp (FLAS herbarium material, 16 specimens) but only 12 parsimony-informative sites (and 19 total variable characters), and (3) a combined "total evidence" analysis, i.e., morphology + nrITS, for a pruned data set of 31 specimens (24 field-collected, and 7 herbarium), and 48 variable characters, with 31 of these parsimony informative. All characters were equally weighted and unordered. The morphological analysis used a maximum parsimony (MP) heuristic approach, 500 random-addition replicates, TBR, MaxTree = 200 per replicate, and MulTrees on. Relative support for clades in all analyses was evaluated using a fast-heuristic bootstrap analysis (1000 replicates in the morphological analysis, 100 replicates in the nrITS and combined analyses). The nrITS and analysis used a MP heuristic approach, 100 random-addition replicates, TBR, MaxTree = 10 per replicate, and MulTrees on. The combined analysis was similar but used MaxTree = 10,000. Gaps were coded as missing data; indels were not coded as characters. Morphological character state changes were mapped onto the morphological cladogram and traced onto the total evidence MP cladogram using the PAUP* output in MacClade 4.05 (Maddison & Maddison, 2005). The molecular and morphological analyses resulted in trees with no strongly supported incongruent patterns, so were combined (see "total evidence" analysis, above).

RESULTS

Morphological analysis.—A heuristic search using maximum parsimony yielded 3360 most parsimonious trees (MPTs) with a length of 65 (Consistency Index [CI] = 0.462, Retention Index [RI] = 0.829, Rescaled Consistency Index [RC] = 0.383). The strict consensus tree is shown in Figure 3. *Gaylussacia tomentosa*, *G. nana*, *G. frondosa*, and *G. ursina* form a clade with moderate support (bootstrap [BS] = 78%) in all trees (Fig. 3A). The *G. frondosa* complex, i.e., *G. tomentosa*, *G. nana*, and *G. frondosa*, also forms a clade (BS = 85%; Fig. 3). Within the *G. frondosa* complex, populations of *G. tomentosa* form a clade (without bootstrap support).

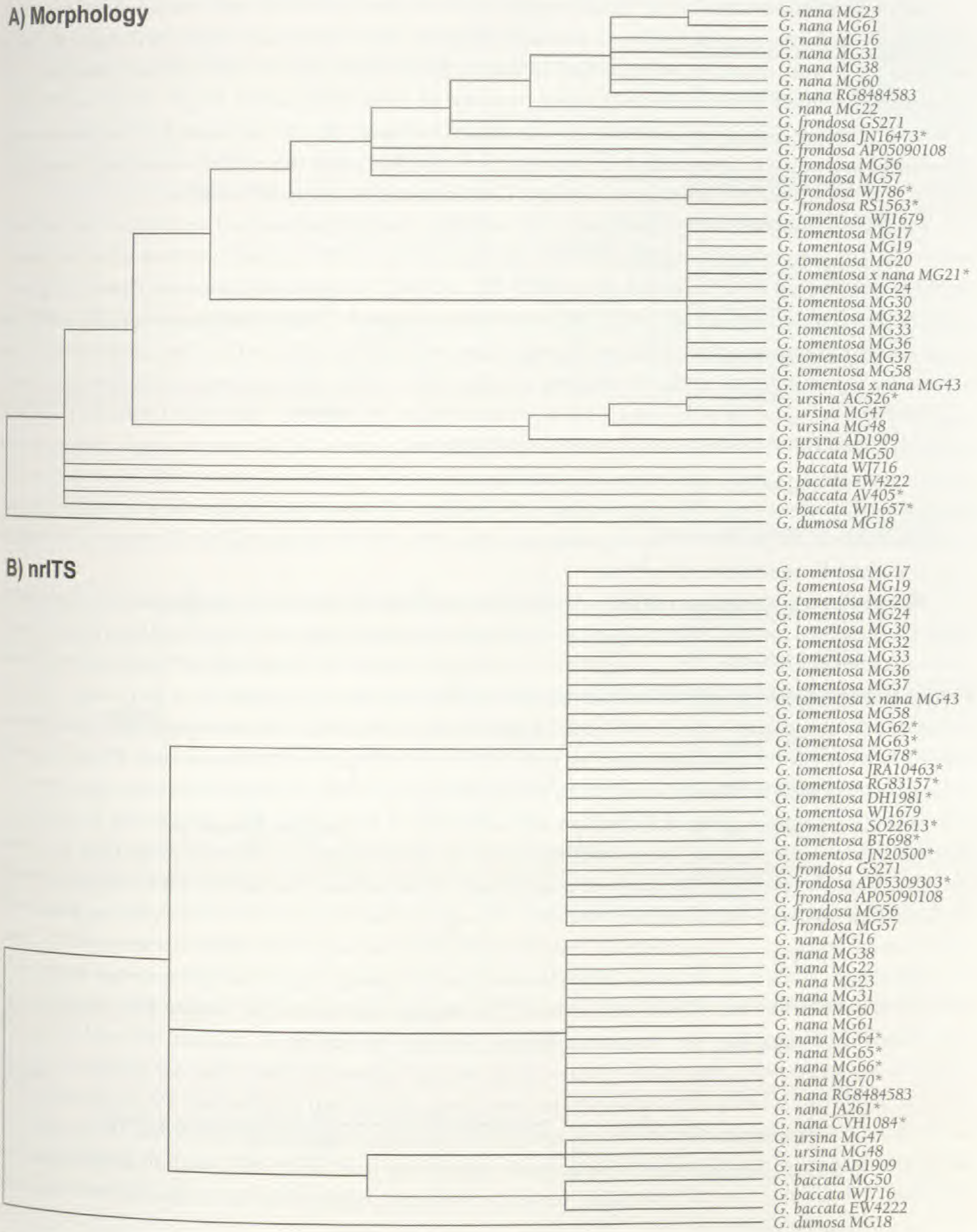
A) Morphology
G. nana MG23
G. nana MG61
G. nana MG16
G. nana MG31
G. nana MG38
G. nana MG60
G. nana RG8484583
G. nana MG22
G. frondosa GS271
G. frondosa JN16473*
G. frondosa AP05090108
G. frondosa MG56
G. frondosa MG57
G. frondosa WJ786*
G. frondosa RS1563*
G. tomentosa WJ1679
G. tomentosa MG17
G. tomentosa MG19
G. tomentosa MG20
G. tomentosa x nana MG21*
G. tomentosa MG24
G. tomentosa MG30
G. tomentosa MG32
G. tomentosa MG33
G. tomentosa MG36
G. tomentosa MG37
G. tomentosa MG58
G. tomentosa x nana MG43
G. ursina AC526*
G. ursina MG47
G. ursina MG48
G. ursina AD1909
G. baccata MG50
G. baccata WJ716
G. baccata EW4222
G. baccata AV405*
G. baccata WJ1657*
G. dumosa MG18
B) nrITS
G. tomentosa MG17
G. tomentosa MG19
G. tomentosa MG20
G. tomentosa MG24
G. tomentosa MG30
G. tomentosa MG32
G. tomentosa MG33
G. tomentosa MG36
G. tomentosa MG37
G. tomentosa x nana MG43
G. tomentosa MG58
G. tomentosa MG62*
G. tomentosa MG63*
G. tomentosa MG78*
G. tomentosa JRA10463*
G. tomentosa RG83157*
G. tomentosa DH1981*
G. tomentosa WJ1679
G. tomentosa SO22613*
G. tomentosa BT698*
G. tomentosa JN20500*
G. frondosa GS271
G. frondosa AP05309303*
G. frondosa AP05090108
G. frondosa MG56
G. frondosa MG57
G. nana MG16
G. nana MG38
G. nana MG22
G. nana MG23
G. nana MG31
G. nana MG60
G. nana MG61
G. nana MG64*
G. nana MG65*
G. nana MG66*
G. nana MG70*
G. nana RG8484583
G. nana JA261*
G. nana CVH1084*
G. ursina MG47
G. ursina MG48
G. ursina AD1909
G. baccata MG50
G. baccata WJ716
G. baccata EW4222
G. dumosa MG18

Fig. 3. Strict consensus trees resulting from (A) the morphological analysis and (B) the nrITS analysis. Collector's names abbreviated by initials (see Table 1). OTUs unique to a particular analysis indicated with an asterisk. See results for bootstrap values.

which is sister to a clade comprising the populations of *G. frondosa* and *G. nana* (without bootstrap support). Within the *G. frondosa* + *G. nana* clade, the populations of *G. nana* form a clade (BS = 58%), which is nested within a paraphyletic *G. frondosa*. The terminals representing populations of *G. ursina* also form a clade (BS = 73%), but *G. baccata* is unresolved at the base of the *Decamerium* clade.

nrITS analysis.—None of the plastid regions showed phylogenetically informative variation, so after preliminary work these regions were not pursued. However, the 47 sequences of the nrITS region did show useful variation and, therefore, were studied further. A MP heuristic search (100 replicates, MaxTrees = 10 per replicate) of the nrITS sequences resulted in a total of 1000 MPTs with a length 33 (CI = 0.970, RI = 0.992, RC = 0.962). The strict consensus tree is shown in Figure 3B. The monophyly of *Gaylussacia nana* (BS = 56%) was weakly supported. A *G. tomentosa* + *G. frondosa* clade (BS = 95%) was strongly supported. A third clade in the strict consensus tree groups *G. baccata* and *G. ursina* (BS = 69%).

Combined analysis.—The combined total evidence analysis included all specimens that had both successfully sequenced nrITS regions and morphological data. A MP heuristic search resulted in a total of 1000 MPTs of length 89 (CI = 0.663, RI = 0.878, RC = 0.582). A representative tree is shown in Figure 4, with the strict consensus and bootstrap consensus values mapped. Clades *Gaylussacia nana* (BS = 91%) and *G. tomentosa* + *G. frondosa* (BS = 87%) are strongly supported and are sister in the strict consensus tree, thus supporting the monophyly of the *G. frondosa* complex (BS = 62%). All specimens of *G. tomentosa* form a monophyletic group in the strict consensus tree (but without BS support). Specimen *Gajdeczka* 43 (MG43), probably a hybrid (see below), and the operational taxonomic units (OTUs) representing *G. frondosa* form a paraphyletic grade in the *G. tomentosa* + *G. frondosa* clade, and *G. frondosa* forms a clade only in some of the equally parsimonious trees. The *G. tomentosa* + *G. frondosa* + *G. nana* clade is sister to a strongly supported *G. ursina* clade in the SC (BS = 95%). A *G. baccata* clade (BS = 100%) is sister to the *G. ursina* + *G. tomentosa* + *G. frondosa* + *G. nana* clade (BS = 59%).

Morphological synapomorphies.—Mapping morphological characters onto a randomly chosen MPT from the combined (or total evidence) analysis showed that most clades were supported by at least two morphological synapomorphies. The monophyly of *Gaylussacia nana* in the combined MPT was supported by six character states: short non-glandular hairs on both adaxial and abaxial surfaces of the leaf (chars. #5, 6, and 7, Table 2), short and narrow blades (#11 and 12) and short petioles (#13). The monophyly of *G. tomentosa* was supported by dense non-glandular hairs on both adaxial and abaxial leaf surfaces (chars. #4 and 7), as well as long hairs on the branches (#3) and on the abaxial leaf surface (#8). *Gaylussacia tomentosa* specimens also were less glaucous than those of *G. frondosa* and especially *G. nana* (char. #10, see also Fig. 1). *Gaylussacia frondosa* (when monophyletic) was poorly supported by morphological synapomorphies: most *G. frondosa* specimens are characterized by sparse or absent hairs on the adaxial leaf surface (char. #4) and medium-length leaf hairs on the abaxial surface (char. #8), although the variation pattern is homoplasious. In addition, *Gaylussacia frondosa* tends to have fewer unicellular hairs on its twigs than either *G. tomentosa* or *G. nana*.

Specimens of *Gaylussacia ursina* formed a monophyletic group supported by the average length of the non-glandular hairs on the adaxial leaf surface (char. #6) (as opposed to the "longest hair" measurement), long abaxial leaf hairs (#8), the longest and widest blades of all taxa in the analysis (#11 and 12), usually nonglaucous leaves (#10), and sparse glands on the abaxial leaf surface (#9). The monophyly of *G. baccata* was supported by five unique synapomorphies: very dense abaxial leaf glands (char. #9), a red corolla (#17), a cylindrically urceolate corolla (#18), and presence of glands on the adaxial leaf surface (#15). Additional derived features that distinguished it were sparse adaxial leaf hairs (char. #7), medium length abaxial leaf hairs (#8), black coloration of fruits (#16), presence of filament hairs (#19), lack of glaucousness (#10), and narrow leaf blades (#12).

The *Gaylussacia tomentosa* + *G. frondosa* clade was supported mainly by features that differentiate it from *G. nana*: tall plant height (char. #1), long adaxial leaf hairs (#5 and 6), dense abaxial leaf glands (#30), long and wide leaf blades (#11 and 12), and long petioles (#13). The monophyly of the *G. tomentosa* + *G. frondosa* + *G. nana* clade was supported by dense abaxial leaf hairs (char. #30), leaves with slight to intense glaucousness (#10; in many specimens, but lost in some, especially *G. tomentosa*), blue fruits (#16), and glabrous filaments (#19). Finally, the monophyly of the *G. tomentosa* + *G. frondosa* + *G. nana* + *G. ursina* clade was supported by a lack of adaxial leaf glands (char. #15), greenish-white to pinkish-white coloration (#17) of the broadly urceolate corolla (#18), and resin glands lacking exudate (#20).

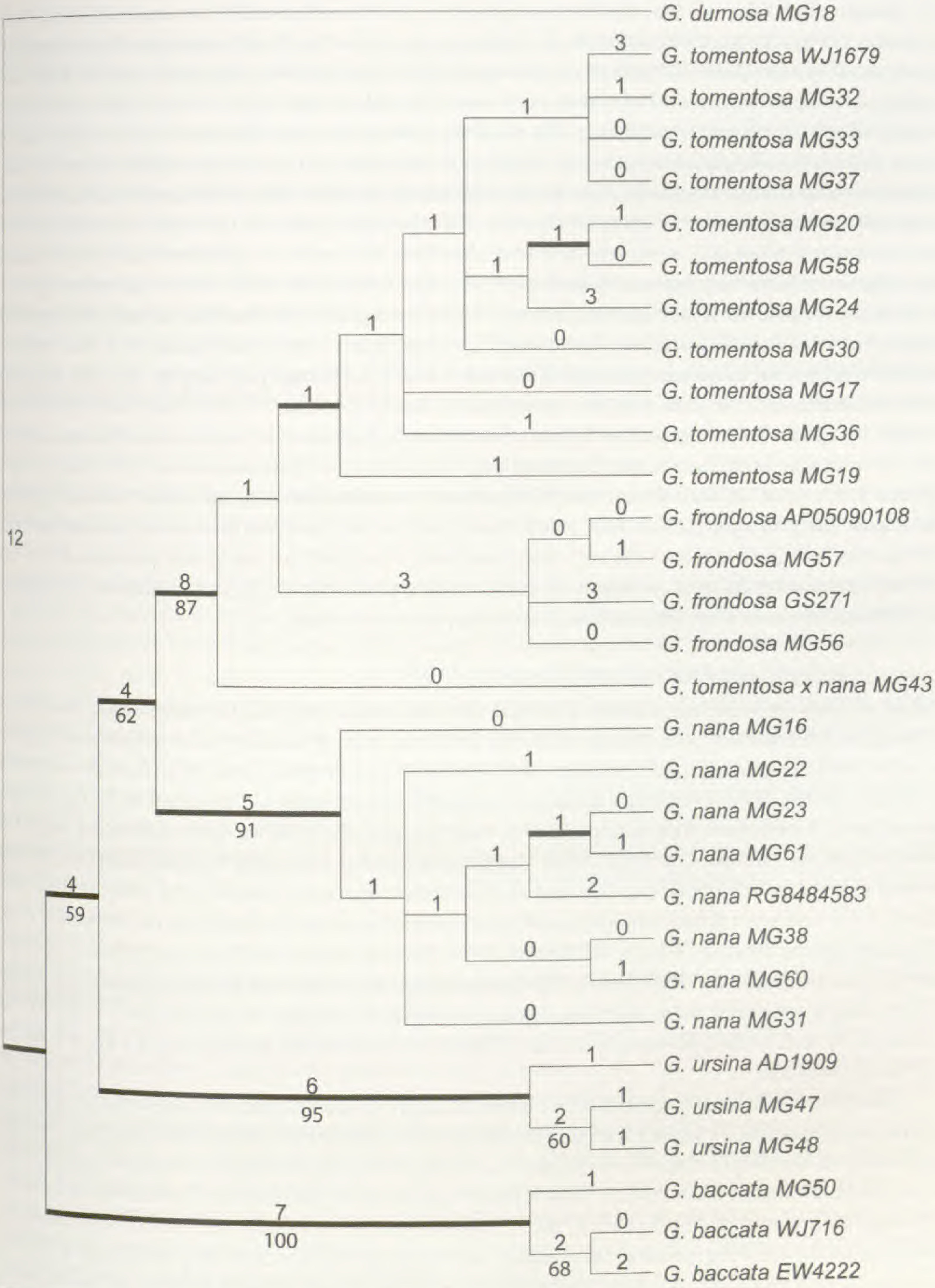
G. dumosa MG18
3
G. tomentosa WJ1679
1
1
G. tomentosa MG32
0
G. tomentosa MG33
0
G. tomentosa MG37
1
1
G. tomentosa MG20
1
1
0
G. tomentosa MG58
3
G. tomentosa MG24
1
0
G. tomentosa MG30
0
G. tomentosa MG17
1
1
G. tomentosa MG36
1
G. tomentosa MG19
1
0
G. frondosa AP05090108
0
12
1
G. frondosa MG57
8
87
3
3
G. frondosa GS271
0
G. frondosa MG56
0
G. tomentosa x nana MG43
4
62
0
G. nana MG16
1
G. nana MG22
5
0
G. nana MG23
91
1
1
1
G. nana MG61
4
1
2
G. nana RG8484583
59
1
0
G. nana MG38
0
1
G. nana MG60
0
G. nana MG31
1
G. ursina AD1909
6
1
G. ursina MG47
95
2
60
1
G. ursina MG48
1
G. baccata MG50
7
0
G. baccata WJ716
100
2
68
2
G. baccata EW4222

FIG. 4. A representative tree from the combined nrITS and morphology analysis. The numbers above the lines represent the number of character changes. Nodes present in the strict consensus tree are indicated by bold lines; bootstrap consensus values provided below the lines. Individual OTUs indicated by abbreviation of collector names along with the collection number (see Table 1).

Putative hybrids.—Various specimens are putatively hybrids between *G. tomentosa* and *G. nana* (*Orzell & Bridges 19346*, *Herring 1548*, *Gajdeczka 21*, *Gajdeczka 43*, *Gajdeczka 75*, and *Gajdeczka 76*) or between *G. frondosa* and *G. nana* (*Judd 3118*) and all are deposited at FLAS. Most of these specimens were excluded from analysis because of the intermediate nature of the data. The interspecific hybrid status of these specimens is supported by both DNA and morphology. The putative *G. tomentosa* × *nana* hybrids are noteworthy in having leaves that are usually glaucous (and thus similar to *G. nana*) but also have long unicellular hairs on their abaxial surfaces (like *G. tomentosa*); their leaves often are also smaller then is characteristic of *G. tomentosa* (especially so in *Gajdeczka 21*), again like *G. nana*. The specimen *Judd 3118* has small, abaxially glaucous leaves (similar to those of *G. nana*), but their adaxial surfaces are essentially glabrous (like *G. frondosa*), and the twigs are only sparsely pubescent (again, similar to *G. frondosa*). For nrITS, there exist polymorphisms at all of the variable nucleotide positions among these three species. For example, at base 163 in our ITS matrix, there is a variable nucleotide C or T, with C occurring in *G. tomentosa/frondosa* vs. T in *G. nana*; all hybrids exhibit a strong polymorphic signal for both C and T. Additional polymorphic sites (substitutions) are found at sites 207, 344, 358, 679, 682, as well as two indels (insertion/deletion) from bases 704–711 and a single base indel at 739. Because we did not clone these PCR products to separate the different copies of ITS, we cannot be certain of the distribution of these characters and their association with either parental species. However, it has been shown that PCR-mediated recombination can cause false or mixed signal of the original parental types (Lahr & Katz 2009). Nonetheless, we are confident that these sequences represent interspecific hybrids because of the high association of the polymorphic nucleotide positions only at the variable sites among different species and at every variable site among the species in question (see Soltis et al. 2008) and because of the intermediate morphology discussed above.

DISCUSSION

Taking all three analyses into account, it is clear that *Gaylussacia nana* and *G. tomentosa* are cladospecies (Donoghue 1985; Mishler 1985; Mishler & Theriot 2000), i.e., each of these species is a monophyletic group of populations (see Donoghue 1985; Mishler 1985; Mishler & Theriot 2000). Thus, both should be recognized as distinct species. We note that they are largely sympatric and are easily distinguished by the morphological characters listed above. The monophyly of *G. nana* is supported by all analyses, with strong support in the combined analysis (see Fig. 4, BS = 91%). Diagnosable features for *G. nana* included short hairs on both adaxial and abaxial leaf surfaces, short and narrow blades, and short petioles (and compare these with features of *G. tomentosa* above). Recognition of these two species is also justified from the perspective of the diagnostic species concept (Wheeler & Platnick 2000; Davis & Nixon 1992), and the phenetic/taxonomic species concept (Judd et al. 2007; Smith 1994) as evidenced by the data presented in Duncan and Brittain (1966). Finally, they must surely represent distinct evolutionary lineages (de Quieroz 2007; Wiley 1978) as evidenced by their reciprocal monophyly and difference in chromosome number (i.e., $n = 12$ in *G. nana*, $n = 24$ in *G. tomentosa*).

Given that *Gaylussacia tomentosa* and *G. nana* are largely sympatric, and very frequently co-occurring, it is not surprising that we found a few morphologically intermediate specimens—likely hybrids—that also exhibited polymorphic ITS sequences (possibly as a result of their possessing ITS sequences representative of the parental species). The frequency of such plants appears to be quite low (i.e., 7 specimens out of nearly 200 observed); most individuals (both in the field and herbarium) are easily determined. More research is necessary on the breeding system of these plants, and the ploidy levels of both the parental species and the putative hybrids needs to be assessed. Despite the occurrence of these putative hybrids, we believe that *G. nana* and *G. tomentosa* are largely reproductively isolated (possibly by the difference in chromosome number), thus fitting the biological species concept (Mayr 1969).

The results presented here provide strong support for the treatments of Small (1933), Camp (1935, 1941), Wood (1961), Duncan and Brittain (1966) and Luteyn et al. (1996), all of whom distinguished *G. nana* and *G. tomentosa* at the species level. Recognition at the varietal level, as proposed or adopted by Gray (1878), Chapman (1889), Harper (1906), Radford et al. (1964), Sleumer (1967), and Floyd (2002) is considered inappropriate. A monophyletic *Gaylussacia tomentosa* is present in the nrITS and combined strict consensus trees, albeit without BS support, although the morphological analysis does not resolve *G. tomentosa* into a clade in all trees (see Fig. 3). Twelve morphological characters distinguish *G. tomentosa* from *G. nana* (Table 2, chars. #2–9, 11–13). Five of the characters also separate *G. tomentosa* from *G. frondosa* (chars. #2, 3, 4, 6 and 7); these vary infraspecifically to a greater extent within *G. tomentosa* and *G. frondosa* than in *G. nana*, except branch hair length (char. #3, Table 3). Finally, the difference in ploidy distinguishes *G. tomentosa*, which is the only tetraploid in the subsection (Löve 1976; Luteyn et al. 1996), providing a distinctive apomorphic feature for this taxon.

The taxonomy of *Gaylussacia frondosa* is more problematic. *Gaylussacia frondosa* has no support as a monophyletic group in any of the strict consensus trees, yet the monophyly of this taxon is supported in some of the most parsimonious trees resulting from the combined analysis (Fig. 4). The two character states that could be considered diagnostic for *G. frondosa* are the absence of adaxial leaf hairs except for the midvein and margin (char. #4; Tables 2, 3) and medium-length abaxial leaf hairs (#23). However, their pattern of variation is homoplasious. Thus, *G. frondosa* lacks clear morphological autapomorphies, which likely contributes to its lack of support in the nrITS and morphological analyses. Although placed as a close relative of *G. tomentosa* in the combined analyses, we note that these two taxa can be clearly differentiated by chromosome number, $n = 12$ in *G. frondosa* and $n = 24$ in *G. tomentosa* (Löve, 1976; Luteyn et al., 1996). In addition, *G. frondosa* has a more northern distribution (to NH and MA; Luteyn et al. 1996; Camp 1935) than does *G. tomentosa*, so in large parts of their ranges they are allopatric. It is commonly reported that *G. frondosa* can often reach heights of 2–3 m (Luteyn et al. 1996; Camp 1941), while *G. tomentosa* seldom reaches heights above 1.5 m (Luteyn et al. 1996). Camp (1941) also mentioned the highly clonal habit of *G. tomentosa* and *G. nana*, as opposed to the more spread out, less rhizomatous habit of *G. frondosa*.

Most putative *Gaylussacia tomentosa* × *nana* hybrids were not included in the nrITS analyses due to their polymorphic sequences, however, *Gajdeczka 43* was included (Figs. 3, 4) as its ITS sequence is fairly clear. This specimen (as discussed under results) is morphologically intermediate between *G. tomentosa* and *G. nana* (e.g., it has intermediate-length hairs on the abaxial leaf surface, and it may have been slightly glaucous) and its nrITS sequence shows a slight indication of polymorphism at the variable nucleotide positions (i.e., small secondary peaks are present at the polymorphic sites). The ITS sequence of this specimen was coded using the major peaks at these sites, and thus it was placed in the *G. tomentosa/frondosa* clade (instead of the *G. nana* clade) in the ITS tree (Fig. 3B). Had these sites been coded as polymorphic its position in the cladogram would have been unresolved (within the *G. frondosa* complex). Its more isolated placement in the strict consensus of the combined analysis (Fig. 4), i.e., sister to the remaining members of the *G. tomentosa* + *G. frondosa* clade, results from the interplay between the ITS sequence (with characters arbitrarily coded as those of *G. tomentosa*) and the presence of certain morphological characters of *G. nana*, e.g., shorter hairs on the abaxial leaf surface. *Gajdeczka 43* is placed in the *G. tomentosa* clade (Fig. 3) in the morphology-based analysis due to the more numerous apomorphies of this species (and indeed, this specimen is phenetically most similar to *G. tomentosa*). Another putative hybrid, *Gajdeczka 21*, was included in the morphology-based phylogenetic analysis, and this plant, like *Gajdeczka 43*, was placed in the *G. tomentosa* clade, likely as a result of its expressing more synapomorphies of *G. tomentosa* than *G. nana* (as coded in our matrix). Of course, such placements are influenced by the necessarily somewhat arbitrary delimitations of some of the morphological character states (see methods). The nrITS sequence of *Gajdeczka 21* allows us to confidently hypothesize that this specimen represents a hybrid individual, and its placement with *G. tomentosa* accessions in the morphological strict consensus tree (Fig. 3A) does not cause us to doubt that it is very likely of hybrid origin. Such placements of hybrid individuals are to be expected (McDade 1990, 1992).

Gaylussacia baccata and *G. ursina* were considered outgroups in this study, and as such, their intraspecific taxonomy was not assessed (Floyd 2002). In addition, their species limits have not been controversial. Each is supported as a cladospecies in the total evidence trees (Fig. 4). Strangely, *G. baccata* is paraphyletic in the morphology-based trees (forming the basal branches of the cladogram).

The nrITS analysis resulted in some unexpected results, e.g., *Gaylussacia baccata* and *G. ursina* formed a clade (Fig. 3B), although the resolution of the analysis was too poor to shed light on subsectional relationships, likely as a result of insufficient phylogenetically informative characters. Floyd's (2002) nrITS topology was similarly unexpected (i.e., sect. *Decamerium* was shown as polyphyletic), and her nrITS data was incompatible with her *trnL-trnF* data (as assessed by a partition homogeneity test). Possible lineage sorting or hybridization events affecting the nrITS region might be contributing to the observed irregularities (Floyd 2002), and it should be noted that Floyd coded indels as additional characters, while we did not. Understanding the discrepancies between nrITS sequences and other data sets used for hypothesizing phylogeny in *Gaylussacia* requires additional study.

Our morphological ingroup topography also shows discrepancies with the nrITS and combined topographies, i.e., *Gaylussacia frondosa* groups with *G. nana* (rather than *G. tomentosa*) in the morphological trees. Three character states are synapomorphies of the *G. frondosa* + *G. nana* clade in the morphological tree: habit (#2), short non-glandular hairs on the stems (#3), and moderately dense hairs on the abaxial leaf surface (#7). Floyd's (2002) morphological analysis places a *G. tomentosa* + *G. nana* clade (BS = 73%) sister to *G. frondosa*; *G. tomentosa* and *G. nana* also group together in Floyd's *trnL-trnF* topology. Her analysis, however, did not include any morphological character states that were shared by *G. nana* and *G. frondosa*, but also differed from those of *G. tomentosa*. Our characters #2 and 3 are not treated in Floyd's study, while character #7 is coded similarly for *G. frondosa* (but the state is shared with *G. nana*), and we note that it is not unexpected in analyses involving different evolutionary units to employ different morphological characters, or state delimitations. Also in her analysis, several character states relating to hair density (glabrous twigs, adaxial leaf surfaces and leaf margins, few hairs on abaxial leaf surface) are unique to *G. frondosa*, and thus separate it from *G. tomentosa* and *G. nana*. Twig hair density was measured in our study (and *G. frondosa* does have the least dense hairs), but this character was excluded from our analyses because it follows a similar pattern of variation as other hair density characters. It is possible that glabrous to sparsely pubescent twigs could represent a synapomorphy for the populations of *G. frondosa*.

Finally, the morphological (BS = 85%) and combined (BS = 62%) data support the recognition of a monophyletic *Gaylussacia frondosa* complex (i.e., subsect. *Frondosae*) as it is commonly treated (Camp 1941; Sleumer 1967; Floyd 2002). In the majority rule consensus tree of the nrITS analysis (not shown), a *G. baccata* + *G. ursina* clade is sister to a *G. tomentosa* + *G. frondosa* clade in 52% of trees (with *G. nana* sister to all four species). In Floyd (2002) a *G. tomentosa* + *G. frondosa* + *G. nana* clade was evident in most analyses.

In conclusion, within *Gaylussacia* sect. *Decamerium* subsect. *Frondosae*, it is clear that the largely sympatric *G. nana* and *G. tomentosa* each represent distinct species (regardless of the species concept applied), while the evidence for the distinctiveness of *G. frondosa* is more problematic—although our analyses provide some preliminary evidence that it, too, should be recognized as specifically distinct (Fig. 4). An identification key for these species is available in Luteyn et al. (1996). More work, however, needs to be done to determine relationships within the complex, as the analyses are incongruent in the placement of *G. frondosa*, the representatives of which are more closely related to *G. nana* in the morphological analysis and are more closely related to *G. tomentosa* in the nrITS analysis. We also recommend additional investigations on the ploidy level of members of subsect. *Frondosae*, especially the putative hybrids.

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POPULATION GENETIC ANALYSIS OF *ARGEMONE PLEIACANTHA* SUBSP. *PINNATISECTA* (SACRAMENTO PRICKLY POPPY, PAPAVERACEAE) AND RE-EVALUATION OF ITS TAXONOMIC STATUS

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ABSTRACT

Argemone pleiacantha subsp. *pinnatisecta* (Sacramento Prickly Poppy) is a federally listed endangered member of Papaveraceae, known from a few small populations on the western slope of the Sacramento Mountains in Otero County, New Mexico. With the total number of established *A. pleiacantha* subsp. *pinnatisecta* apparently dwindling, and threats to the viability of the taxon coming from a variety of factors, the taxonomic status of this group is of interest to scientists and land managers. The objective of this study was to test whether *Argemone pleiacantha* subsp. *pinnasecta* is diagnosable at the level of species through the application of an AFLP-based molecular assessment of population-level variation. Results from principle coordinate and STRUCTURE analyses on 424 AFLP loci, taken from samples of *Argemone pleiacantha* subsp. *pinnatisecta* and related geographically proximate members of *Argemone*, identify that the Sacramento Prickly Poppy is a genetically unique population system. The results of the AFLP analysis, in combination with the geographic isolation and morphological differentiation, are consistent with applicable widely held concepts of plant species. A new combination, **Argemone pinnatisecta** (G.B. Ownbey) S.D. Cervantes & C.D. Bailey comb. et stat. nov., is presented.

RESUMEN

Argemone pleiacantha subsp. *pinnatisecta* (Sacramento Prickly Poppy) es una Papaveraceae de la lista federal de especies en peligro, conocida solo de pequeñas poblaciones en la ladera occidental de las montañas de Sacramento en el condado de Otero, Nuevo México. Con el número de individuos de *A. pleiacantha* subsp. *pinnatisecta* aparentemente disminuyendo, y con las amenazas para la viabilidad de este taxon provenientes de una variedad de factores, el estado taxonómico de este grupo es de interés. El objetivo de este estudio era probar si *A. pleiacantha* subsp. *pinnatisecta* es diagnosticable como especie a través de un estudio de variabilidad poblacional basado en datos de AFLP. Análisis de coordenadas principales y utilizando el programa STRUCTURE en 424 loci de AFLP tomados de muestras de *A. pleiacantha* subsp. *pinnatisecta* y otros miembros relacionados de *Argemone* geográficamente próximos, revelan que este taxon tiene un sistema genético único. Estos resultados, conjuntamente con el aislamiento geográfico y la diferenciación morfológica, son consistentes con conceptos frecuentemente aplicados y científicamente justificados para el reconocimiento de especies de plantas. Basado en esto, se presenta una nueva combinación, **Argemone pinnatisecta** (G.B. Ownbey) S.D. Cervantes & C.D. Bailey comb. et stat. nov.

INTRODUCTION

Our understanding of species has changed dramatically throughout the history of botanical nomenclature. Although disagreement persists, contemporary species concepts broadly agree in viewing species as morphologically and/or genetically discontinuous groups of populations (e.g., Nixon & Wheeler 1990) that are related to each other through common evolutionary history, with reproductive isolation playing a key role in creating discontinuity in sexual taxa (e.g., Dobzhansky 1935; Mayr 1942). This understanding derives in large part from a fusion of ideas from systematics, paleontology, cytology, and genetics, which became known as the "modern synthesis" (Huxley 1942). Previous authors, especially prior to Darwin's *On the Origin of Species*, largely viewed species as temporally unchanging, but not necessarily morphologically discontinuous, entities that were not connected through evolutionary history. Many treated species and infraspecific ranks merely as tools for naming natural variation, not as fundamental units of evolution.

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Despite dramatic changes over time in how species are understood and delimited, it is common for non-specialists to assume that "species" in contemporary discussions reflect the application of a species concept that is consistent with modern evolutionary biology. However, the majority of the roughly 2.5 million described species (e.g., May 1988) and infraspecific taxa were published prior to the *On the Origin of Species*, much less works of the modern synthesis. Few authors for these taxa were aware that the species rank would one day represent a critical boundary in evolutionary biology.

Ideally the limits of all species would be determined consistently, based on contemporary species concepts, but the scale of such work and limited global investment in the field makes this level of study unlikely in the foreseeable future (e.g., Heywood 2001; Scotland et al. 2003). The historical and potentially arbitrary application of rank at and below the level of species may not impact many taxa. However, over-interpretation of ranks can be an acute problem in conservation, with critics often suggesting that threatened subspecies and varieties are less than "species" and therefore unworthy of protection. When taxa are threatened with global extinction, scientific assignments based on modern concepts of species are critical for our understanding of the taxon and for downstream conservation decisions (see Desalle & Amato 2004; Holsinger & Gottliebo 1991; Van Dyke 2008). This study was conducted to evaluate the species status of one such endangered taxon.

Argemone pleiacantha Greene subsp. *pinnatisecta* G.B.Ownbey (Sacramento Prickly Poppy) is a federally listed endangered member of Papaveraceae, known from a few small populations on the western slope of the Sacramento Mountains in Otero County, New Mexico (Fish & Wildlife Service 1989). In the most recent monograph of *Argemone*, Ownbey (1958) described the taxon from his own specimens and an 1899 Wooton collection. This geographically restricted (Fig. 1) taxon was distinguished from other *Argemone pleiacantha* Greene by the presence of simple bud prickles, paler yellow latex, and sparingly prickly capsules (Fig. 1).

In the introduction to the monograph, Ownbey (1958) explicitly provided a species concept consistent with numerous contemporary concepts. His definition focused on distinctive morphological traits and either geographic isolation or failure to intergrade when occurring in sympatry with other *Argemone*. The morphology and geographic isolation of *A. pleiacantha* subsp. *pinnatisecta* fits this definition; however, Ownbey subsequently recognized the taxon as a subspecies without any discussion of his reasoning. With the exception of Shinners' (1958) overlooked shift in rank to *A. pleiacantha* Greene var. *pinnatisecta* (G.B.Ownbey) Shinners, other taxonomic assessments have not been made since Ownbey's description.

Shinners' shift in rank to variety might easily be misconstrued as his viewing the taxon as a lesser entity than Ownbey. Similar interpretations, commonly applied by non-scientists in arguments against protecting subspecific taxa (e.g., Wilcove et al. 1993), demonstrate the danger of over-interpreting the differential use of ranks (particularly subspecies and varieties) as well as the risk of excluding plant varieties from the formal language in the Endangered Species Act (Wilcove et al. 1993). In actuality, Shinners' taxonomic modification simply reflected his opinion that "One only uses subspecies on the relatively uncommon occasion when it is desired to label a group of varieties." (Shinners 1958) and had nothing to do with isolation or uniqueness of the group.

With the total number of established *A. pleiacantha* subsp. *pinnatisecta* dwindling well below 1000 (Sivinski 1999; Tonne 2008), the unclear rank appropriate for the taxon (species, variety, or subspecies), and threats to its viability coming from aspects of reproductive biology (Sivinski 1992; Tonne 2008) as well a variety of human-related factors (e.g., water withdrawal and right-of-way development, flooding, off-roading, grazing, highway maintenance (Lightfoot and Sivinski 1994; Tonne 2008)), the taxonomic assignment of these plants is of considerable interest.

The objective of this study is to evaluate the genetic structure and distinctiveness of *Argemone pleiacantha* subsp. *pinnasecta* population systems through the application of an AFLP-based (Vos et al. 1995) molecular assessment of population-level genomic variation and to use this information to address the taxonomic status of these plants. AFLPs are randomly sampled genetic loci that, in combination with appropriate methods of analysis, have proven powerful in developing objective fine-scale assessments of population-level and

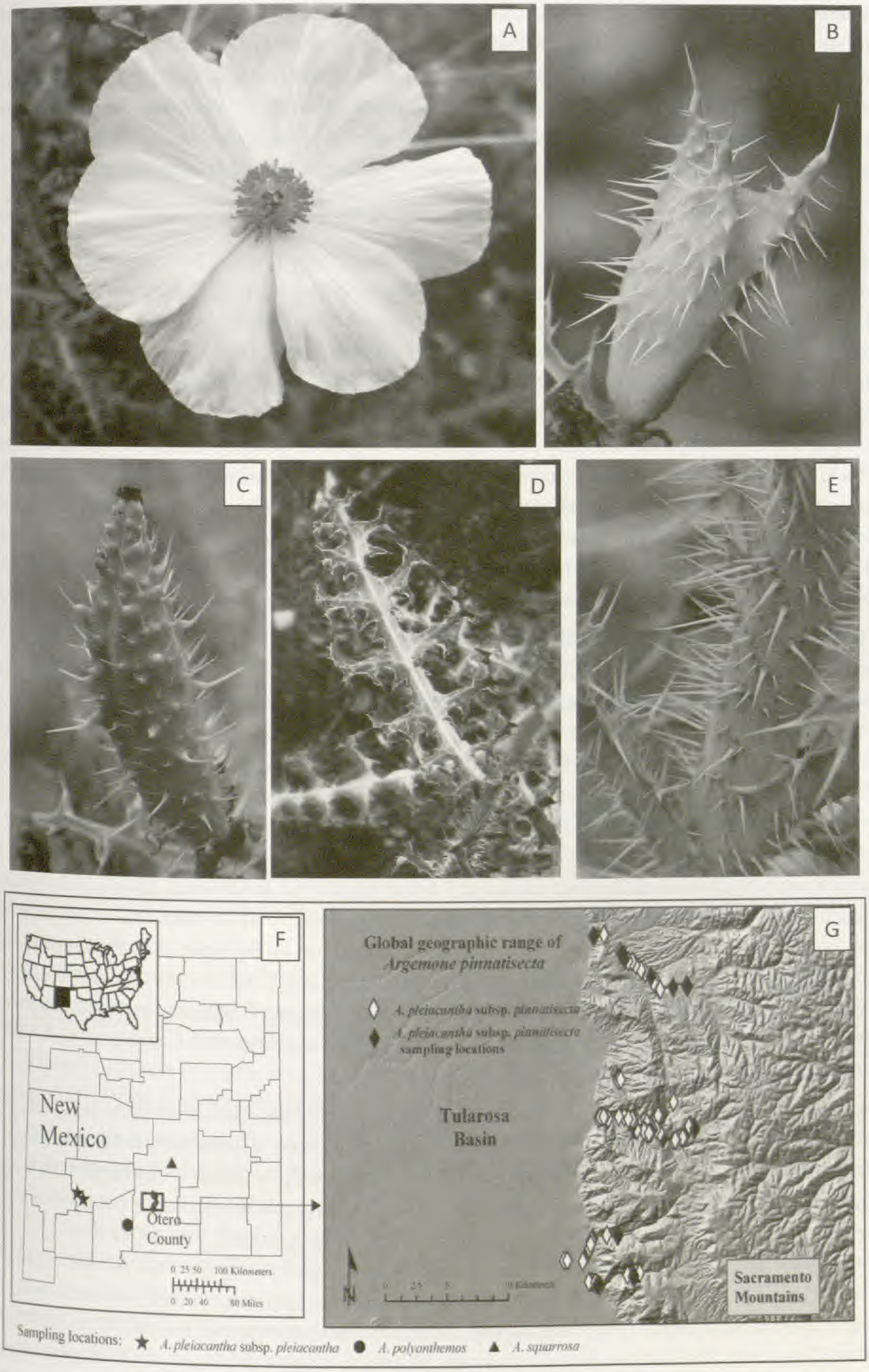
A
B
C
D
E
F
New Mexico
Otero County
0 25 50 100 Kilometers
0 20 40 80 Miles
G
Global geographic range of *Argemone pinnatisecta*
◇ *A. pleiacantha* subsp. *pinnatisecta*
◆ *A. pleiacantha* subsp. *pinnatisecta* sampling locations
Tularosa Basin
0 2.5 5 10 Kilometers
N
Sacramento Mountains
Sampling locations: ★ *A. pleiacantha* subsp. *pleiacantha* ● *A. polyanthemos* ▲ *A. squarrosa*

Fig. 1. **Geography and Morphology.** *Aregemone pleiacantha* subsp. *pinnatisecta* morphology (A–E). **A)** Flower and Bud, **B)** Bud, **C)** Capsule, **D)** cauline leaf, **E)** stem prickles. **F)** Geography of sampled material included in the study. **G)** The known geographic distribution of *A. pleiacantha* subsp. *pinnatisecta* (open diamonds) and the specific sampling of the species included (dark diamonds).

species-level variation in many plant and animal groups (e.g. Bacon & Bailey 2006; Baskauf & Burke 2009; Duminil et al. 2006; Martinez-Ortega et al. 2004; Routtu et al. 2007). For this study, AFLP profiles from *A. pleiacantha* subsp. *pinnatisecta* populations were compared to all geographically proximate species of *Argemone*. Results relating to the genetic isolation and differentiation of *A. pleiacantha* subsp. *pinnatisecta* are discussed to assess whether the taxon is a species based on scientifically accepted concepts of the species, or if these represent geographic, but not genetically distinct, populations of proximate species.

MATERIALS AND METHODS

Sampling.—Multiple collecting trips to *Argemone* localities in New Mexico were made between June and August of 2007. *Argemone pleiacantha* subsp. *pinnatisecta* were collected from 12 localities representing four canyon systems that run east to west across the Sacramento Mountains (Alamo, San Andres, Dog, and La Luz/Fresnal Canyons – Fig. 1 and Appendix 1). *Argemone pleiacantha* subsp. *pleiacantha* was collected from Kingston and Hillsboro, *A. polyanthemos* (Fedde) G.B.Ownbey from San Augustin Pass near Las Cruces, and *A. squarrosa* Greene from the eastern Sacramento Mountains (Fig. 1 and Appendix 1). The latter three taxa were sampled because they are the only other species of *Argemone* geographically proximate (within 150 miles) to *A. pleiacantha* subsp. *pinnatisecta* and because they are among a number of possible close relatives to *A. pleiacantha* subsp. *pinnatisecta* identified in a phylogenetic analysis of *Argemone* (Schwarzbach & Kadereit 1999). With the exception of the endangered *A. pleiacantha* subsp. *pinnatisecta*, which is sufficiently represented by specimens in the NMSU Dept. of Biology Herbarium (NMC – Thiers 2009), a voucher specimen was collected from each locality and deposited in NMC (Appendix 1).

DNA Extraction and AFLP Amplification.—DNA samples were extracted from each individual using the DNA extraction protocol of Alexander et al. (2007) eluting DNA into 10 mM Tris. DNA quantity and quality were evaluated on 0.7% agarose gels with a 100 bp DNA mass ladder standard (New England Biolabs). The restriction ligation (RL) and preselective amplifications followed a modified Vos et al. (1995) AFLP approached used by Bacon and Bailey (2006) and marketed by Applied Biosystems ("Plant Mapping Protocol" – P/N 402977 rev. E). In short, 50 ng of genomic DNA was digested overnight at 37°C with 1X T4 Ligase buffer (NEB), 0.046 M NaCl, 0.046 M BSA, 1 pM MseI Adapter pair, 10 pM *Eco*RI Adapter Pair, 1 U *Mse*I, 5 U *Eco*RI, and 67 U of T4 ligase (NEB). RLs were diluted to a final volume of 200 µL with 0.1 X TE. Preselective and selective amplifications included 1.5 mM $MgCl_2$ 0.1 M Tris-HCl pH 8.3, 0.5 M KCl, 0.25 µM of each primer, and ca. 2 U *Taq* in a 20 µL reaction containing 4 µL of dilute RL or preamplification product. Preselective amplifications applied single selective bases on each primer (A on *Eco*RI and C on *Mse*I) and selective primer combinations included *Eco*RI-AC/*Mse*I-CTA and *Eco*RI-TC/*Mse*I-CTA. Preselective and selective amplification cycling followed the ABI Plant Mapping Protocol. Selective amplification reactions, labeled with 5'FAM on the *Eco*RI primer, were run on a 3100 sequencer (Applied Biosystems) with a ROX500 standard (Applied Biosystems).

Data Analysis.—AFLP profiles were extracted from raw sequence files and converted to comparative allele presence/absence tables using GeneMapper 4.0 (Applied Biosystems). Alleles used in the analyses ranged from 100–500 bp. Runs on single individuals were considered to have failed if the number of fragments amplified was below the mean and standard deviation of fragments amplified across the population. In almost all cases, these failed runs correlated with low quality DNA and generated few or no peaks.

Two approaches were implemented to assess the number of genetically distinct clusters of individuals supported by the AFLP data irrespective of previously conceived notions of species or population limits. First, a principle coordinate analysis (PCO) employing Euclidean distances was run in MVSP ver. 3.131 (Kovach Computing Services). The first two coordinates were plotted to display the degree of differentiation among groups. This visual approach was augmented by the Bayesian statistical analysis presented by Pritchard et al. (2000). The application of STRUCTURE vers. 2.3.1 (Pritchard et al. 2000) tested relative likelihood support in the data for K genetic clusters (K=1–8) and the assignment of each individual to specific clusters under each value of K. The scoring of AFLP patterns in STRUCTURE followed the recommendation of Evanno et al. (2005) in treating the unobserved alleles as missing data (i.e., for an individual with a presence allele at locus X, it is not possible to directly infer if the sample is homozygous dominant [1,1] or heterozygous [1,0]). STRUCTURE analyses included 10,000 burn-ins and MCMC replicates for each run, 10 replicate runs for each value of K, use of the admixture model, and allele frequencies set to independent, as recommended by Evanno et al. (2005). Other parameters were set to the software defaults. The inferred number of clusters best supported by the data was further tested through the application of ΔK (K=1–8) as applied by Evanno et al. (2005).

RESULTS

Of the 93 individuals from which DNA was extracted, 63 were successfully amplified using both selective primer combinations (30 *A. pleiacantha* subsp. *pinnatisecta*, 16 *A. pleiacantha* subsp. *pleiacantha*, 11 *A. squarrosa*, and 6 *A. polyanthemos*). Across these samples, AFLP reactions employing selective primer combinations *Eco*RI-AC/*Mse*I-CTA and *Eco*RI-TC/*Mse*I-CTA amplified 221 and 203 loci, respectively. Each primer combination amplified one fixed presence allele ("private") in every accession of *A. pleiacantha* subsp. *pinnatisecta* that was absent in all other sampled accessions.

Argemone squarrosa is considered polyploid based on chromosome counts from one locality (Ownbey 1958). When analyzed with diploid taxa in distance based analyses the increased number of fragments could generate artifactual results of concern to this study. However, individuals from the locality of *A. squarrosa* sampled for this study produced numbers of AFLP fragments well within the range for all other accessions amplified, reducing concerns with variance in fragment number. It is possible that there are both diploid and polyploid populations of the species and that we sampled diploid individuals.

Interspecific Analyses: PCO analysis (Fig. 2) identified three highly differentiated clusters. All accessions of *A. pleiacantha* subsp. *pinnatisecta* were recovered in a single cluster and the taxon showed greater differentiation from all other accessions than the other three taxa showed among one another. *Argemone squarrosa* and *A. polyanthemos* accessions displayed the lowest degree of differentiation between taxa (Fig. 2).

Results of the Ln P(D) in STRUCTURE supported K≥3 (Table 1). Pritchard et al. (2000) and Evanno et al. (2005) have documented likelihood values continuing to rise after passing the "true" K. This appears to be the case here, were the likelihood of K=3 is considerably higher than the values for K=1 or 2, but K continues to rise slightly and fluctuate above K=3. The application of Evanno et al.'s (2005) method found a 10 fold reduction in ΔK (from 15.95 to 1.61) between K=3 and K=4 (Table 1), identifying strong support for a K=3 conclusion (Evanno et al. 2005).

In all replications of the MCMC method with K>1, representatives of *A. pleiacantha* subsp. *pinnatisecta* were assigned to a single unique cluster, adding credence to the conclusion that these individuals represent a cohesive distinct group. With all values of K>1, no individual of *A. pleiacantha* subsp. *pinnatisecta* had less than 96.3% assignment to the same single cluster and no individuals from the other taxa show greater than 6.2% assignment to the *A. pleiacantha* subsp. *pinnatisecta* cluster (Table 1).

Intraspecific Differentiation: The sampling available for this study largely precluded a comprehensive analysis of intraspecific variation for *A. pleiacantha* subsp. *pinnatisecta*. Nonetheless, some preliminary analyses were run to test for signs of potential population differentiation. A PCO analysis restricted to *A. pleiacantha* subsp. *pinnatisecta* accessions displayed weak differentiation (Fig. 3) between accessions from canyons in the northern and southern portions of the range of the subspecies (see Discussion). The weakness of this differentiation is clear from the results in STRUCTURE, which failed to reject K=1 (Table 2) for the taxon. ΔK cannot be tested for K=1 and was not applied.

DISCUSSION

Taxonomic Status of the Sacramento Prickly Poppy.—The presence/absence pattern of randomly selected AFLP loci amplified from *A. pleiacantha* subsp. *pinnatisecta* and populations of other *Argemone* known within reasonable proximity of *A. pleiacantha* subsp. *pinnatisecta*, are consistent with the Sacramento Prickly

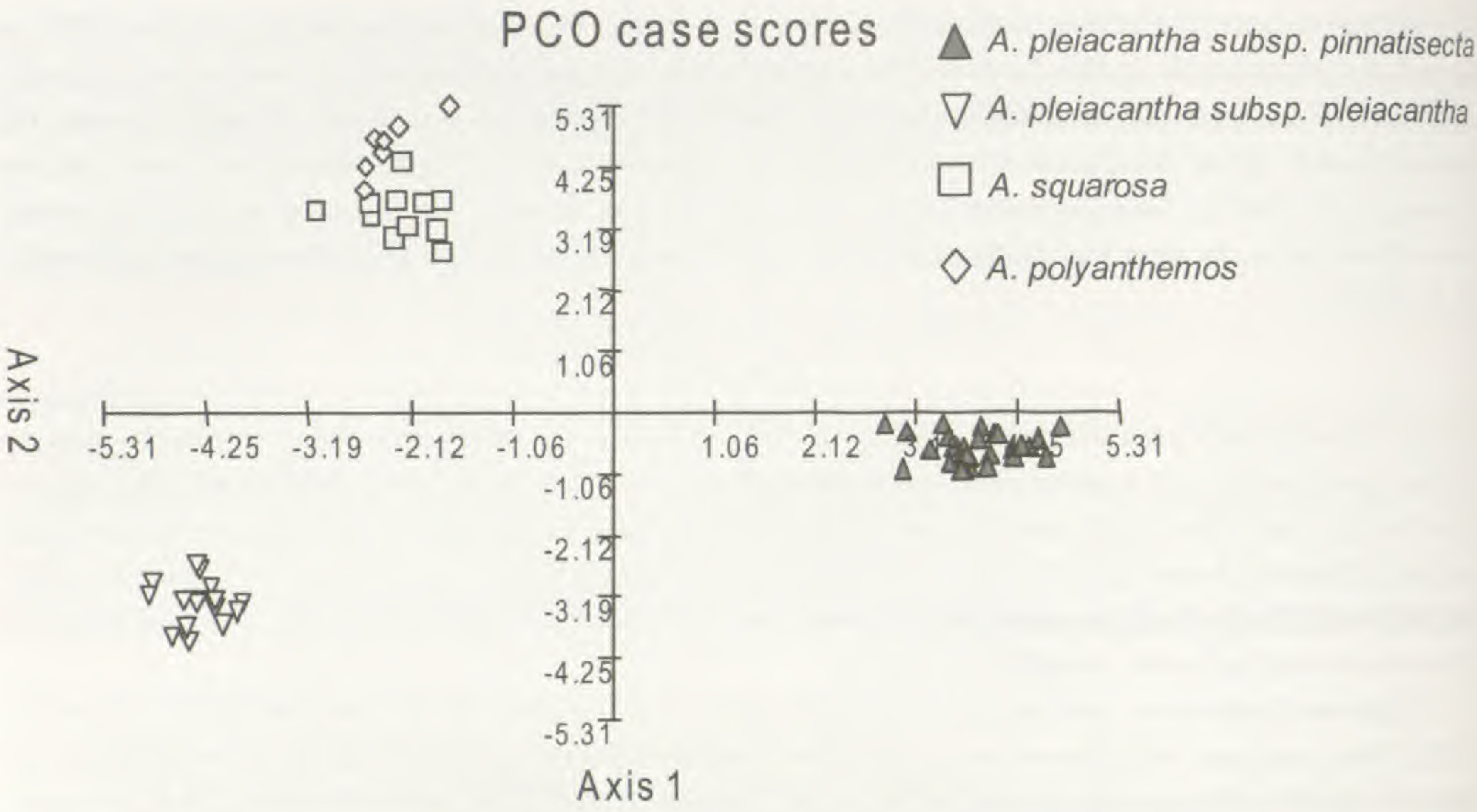

Fig. 2. Interspecific PCO analysis applying Euclidean distances calculated from AFLP data representing 424 loci.

Table 1. Results from the interspecific STRUCTURE analyses with values of K ranging from 1–8. Abbreviations: K - number of distinct groups applied, Ln - log probability, ΔK - rate of change in the log probability between successive values of K.

K=	1	2	3	4	5	6	7	8
mean Ln D(K)	-12945.75	-10190.29	-8810.68	-8748.87	-8439.63	-8509.82	-8534.8	-8504.54
SD Ln D(K)	1.40	67.06	81.46	142.99	239.03	193.04	353.11	199.96
ΔK	NA	20.53	15.95	1.61	1.42	0.188	0.156	NA
SPP CLUSTER - of min. assignment each SPP individual	NA	0.963	0.985	0.985	0.99	0.985	0.974	0.982
SPP CLUSTER - max. assignment of any non-SPP individual	NA	0.062	0.023	0.018	0.029	0.017	0.012	0.005

Poppy being genetically cohesive and reproductively isolated. In particular, the identification of two fixed (private) allelic differences present in all sampled *A. pleiacantha* subsp. *pinnatisecta*, which are absent from the other samples, suggests that the taxon has been reproductively isolated from these other *Argemone* for sufficient time to have: 1) developed unique fixed genetic traits not found in other taxa, or 2) that other geographically and phylogenetically proximate *Argemone* have lost traits that were once common to more species. Furthermore, the fixed allelic differences at two of the 424 loci are not the only differentiating signal loci found in the genetic dataset. Isolation at the level of species is further identified by the sum of allelic frequencies investigated through PCO (Fig. 2) and STRUCTURE (Table 1).

Fixed allelic differences are the explicit delimiting factor in the "phylogenetic species concept" (Davis & Nixon 1992; Nixon & Wheeler 1990), are consistent with the principles of the more widely known "biological species concept" (Dobzhansky 1935; Mayr 1942), and the overall pattern corroborates Ownbey's (pg. 9, 1958) suggestion that that the most important form of speciation in *Argemone* is "… geographic isolation leading to the accumulation of genetic differences in isolated populations." Thus, for the Sacramento Prickly Poppy the combination of genetics, morphology, and geography identify extensive reproductive isolation

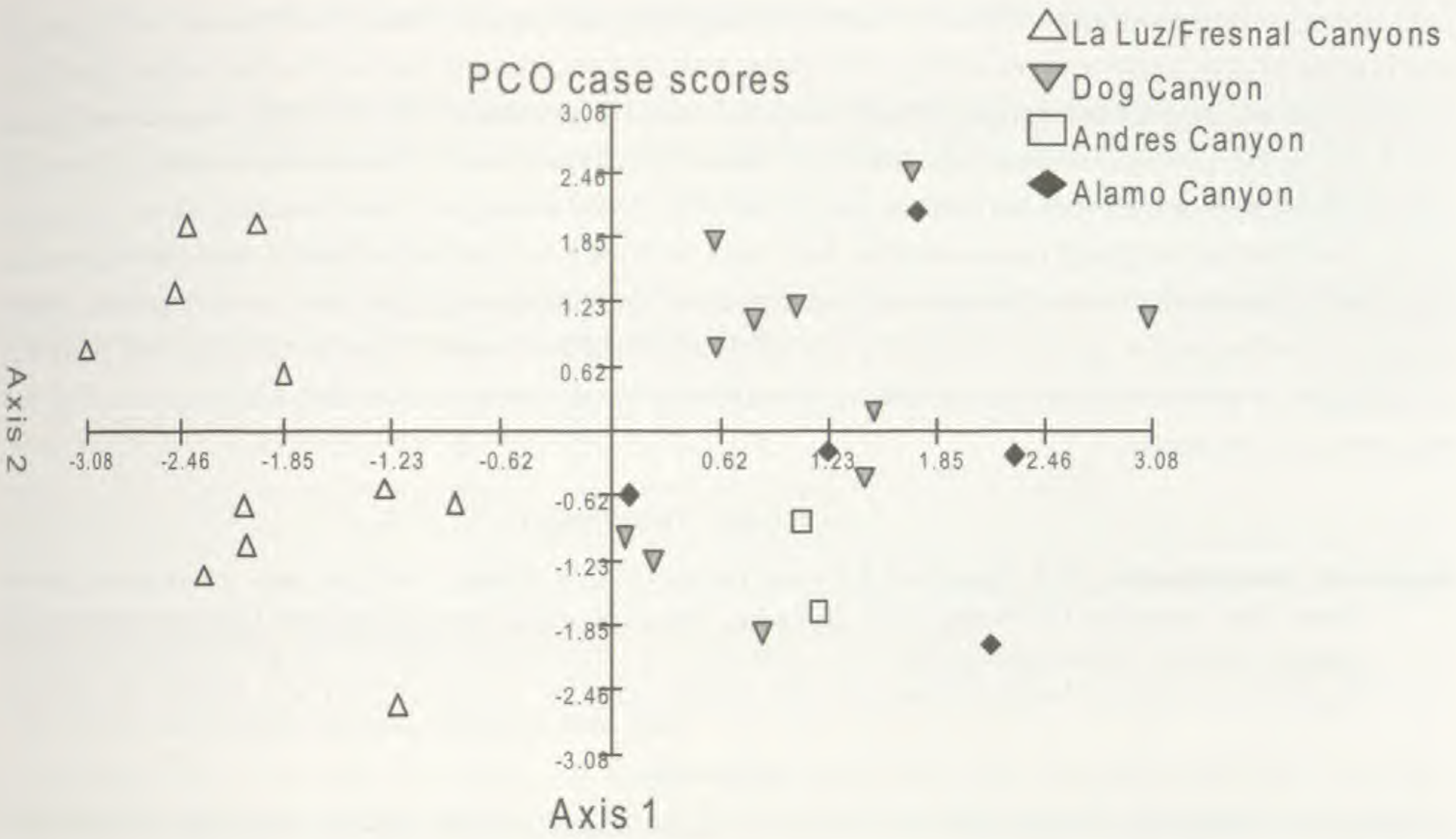

Fig. 3. Intraspecific PCO analysis of *A. pleiacantha* subsp. *pinnatisecta* applying Euclidean distances calculated from AFLP data representing 424 loci.

Table 2. Results from the intraspecific STRUCTURE analyses for *Argemone pleiacantha* subsp. *pinnatisecta* with values of K ranging from 1–8. Abbreviations: K - number of distinct groups applied, Ln - log probability, ΔK - rate of change in the log probability between successive values of K.

K=	1	2	3	4	5	6	7	8
Mean Ln D(K)	-3161.3	-3166.8	-3256.5	-3382.1	-3389.5	-3299.1	-3689.3	-3253.6
SD Ln D(K)	0.81	2.47	281.40	521.27	704.81	510.24	848.12	340.44

from other proximate *Argemone* as well as continued intraspecific contact. These patterns are consistent with specific status under widely accepted concepts of eukaryotic sexual species.

Intraspecific Differentiation.—Analyses of the available *A. pleiacantha* subsp. *pinnatisecta* data set did not reject K=1 for the taxon. However, the PCO analysis of *A. pleiacantha* subsp. *pinnatisecta* (Fig 3) provides evidence for weak divergence of populations found in different canyon systems. The Fresnal and La Luz canyon accessions tend to cluster in one cohort and the three remaining canyon systems into another. Clearly there is no strong population structure on the level of species differentiation, but these preliminary results are of significance to future management practices. Most importantly, resource managers should not assume that genetic variation in the Sacramento Prickly Poppy is randomly distributed across the species' range.

Conclusion and Future Research.—Ownbey's (1958) reasoning for having described the Sacramento Prickly Poppy at the subspecific rank contradicts both his own description of what constitutes a species and the genetic data generated from this study. *Argemone pleiacantha* subsp. *pinnatisecta* is geographically isolated, morphologically distinct, and genetically unique. These features are consistent with contemporary concepts of plant species and are applied here as the scientific evidence behind an elevation in taxonomic rank to species.

This study incorporated taxa growing within 150 miles of *Argemone pleiacantha* subsp. *pinnatisecta* in the southwestern "sky island" system. This distance was selected based on an evaluation of taxa that could conceivably interbreed with *A. pleiacantha* subsp. *pinnatisecta* and what was feasible for the study. Future assessments of species limits within *Argemone* will hopefully address the limits of all species in the group. Of potential relevance to the understanding of *A. pleiacantha* subsp. *pinnatisecta* may be the comparison of three morphologically similar but geographically disjunct taxa (*A. arizonica* G.B. Ownbey, *A. gracilenta* Greene, and *A. pleiacantha* subsp. *ambigua* G.B. Ownbey). Since these taxa are only known from localities at least 300 miles distant, across inhospitable habitat, recent historic or contemporary interbreeding with *A. pleiacantha* subsp. *pinnatisecta* is largely inconceivable, but more inclusive comparative studies may shed light on the origin of *A. pleiacantha* subsp. *pinnatisecta* and aspects of the phylogeographic history of *Argemone*. Further analyses of infraspecific genetic variability and geographic differentiation incorporating greater population sampling for *A. pleiacantha* subsp. *pinnatisecta* should also be carried out to develop an appropriate fine scale assessment of variation.

TAXONOMIC TREATMENT

Argemone pinnatisecta (G.B. Ownbey) S.D. Cervantes & C.D. Bailey, comb. et stat. nov. *Argemone pleiacantha* Greene subsp. *pinnatisecta* G.B.Ownbey, Mem. Torrey Bot. Club 21:99, 1958; *Argemone pleiacantha* Greene var. *pinnatisecta* (G.B. Ownbey) Shinners, Southw. Naturalist 3:213–214. 1958. Type: U.S.A. New Mexico: Otero Co.: 9.6 mi W of Cloudcroft, 6600 ft, 12 Aug 1953, *G.B. Ownbey & Findley 1754* (holotype: MIN; isotypes: ARIZ, BM, CAS, COLO, F, GH, MIN, RM, RSA, UC, UNM!, US)

APPENDIX 1

Sampling Information. For each taxon different collecting localities include location, centroid of population latitude, centroid of population longitude, collector and number, date, and number of samples taken.

Argemone pleiacantha* subsp. *pinnatisecta—Sacramento Mtns. Fresnal Canyon, 32.9698,-105.9010, *Phil Tonne & Bob Sivinski*, 2 Samples. Sacramento Mtns. Dog Bench, 32.7550, -105.8872, *Phil Tonne & Bob Sivinski*, 8 Samples. Sacramento Mtns. Fresnal Canyon, 32.9548, -105.8748, 14 Aug 2007, *Phil Tonne & Bob Sivinski*, 2 Samples. Sacramento Mtns. Fresnal Canyon, 32.9665, -105.8978, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 1 sample. Sacramento Mtns. Dog Bajada, 32.7503, -105.9191, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 5 samples. Sacramento Mtns. La Luz, 32.9817, -105.9257, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 1 Sample. Sacramento Mtns. Fresnal Canyon, 32.9480, -105.8428, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 4 Samples. Sacramento Mtns. La Luz, 32.9817, -105.9257, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 2 Samples. Sacramento Mtns. San Andres Canyon, 32.7826, -105.9013, 15 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 2 Samples. Sacramento Mtns. San Andres Canyon, 32.7826, -105.9013, 15 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 1 Sample. Sacramento Mtns. Fresnal Canyon, 32.9476, -105.8553, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 4 Samples. Sacramento Mtns. Upper Alamo Canyon, 32.8537, -105.8348, 14 Aug 2007, *Phil Tonne & Bob Sivinski s.n.*, 8 Samples. ***A. pleiacantha* subsp. *pleiacantha***—Hillsboro, NM, 32.8249, -107.5421, 19 Jun 2007, *Sandy Cervantes 2*, 14 Samples. Kingston, NM, 32.9187, -107.6873, 19 Jun 2007, *Sandy Cervantes 1*, 13 samples. ***A. polyanthemos***—Organ Mtns, leaf samples taken from plants along I10 - collected from 0.5 mi W of White Sands Missile Range entrance, 32.4381, -106.4866, 26 Jun 2007, *Sandy Cervantes 3*, 13 samples. ***A. squarrosa*** - Lincoln, NM 33.5340, -105.4964, 27 Jun 2007, *Sandy Cervantes 4*, 13 Samples.

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BOOK REVIEW

Henry Connor and John Fountain. 2009. **Plants That Poison: A New Zealand guide.** (ISBN 978-0-478-09398-8, pbk.). Manaaki Whenua Press, P.O. Box 40, Lincoln 7640, Gerald Street, Lincoln, Canterbury, New Zealand. (**Orders:** www.mwpress.co.nz or www.balogh.com (US orders), +64 3 321 9749, +64 3 321 9997 fax, 1-217 355 9413 US fax). $NZ 29.99, $US 45.00, 112 pp., color photos, 7 1/2" × 10".

Plants That Poison: a New Zealand Guide is a very informational no-frills type read. Reminiscent of a textbook in both text and content, this book gets down to the facts right away. Essentially a catalog of poisonous plants found in New Zealand, this read would be helpful to anyone who would like to familiarize themselves with toxic plants and how to avoid them. Being a more serious threat than most people realize, poisonous plants can be found almost everywhere, and it would be wise for one to be knowledgeable. The text is supported with a large number of pictures and is a quick and easy read—*Haden Shibley, Volunteer, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

From the publisher: "Written by a leading authority on poisonous plants and an expert in human poisonings, *Plants that Poison: a New Zealand Guide* is a guide to a selection of plants and mushrooms with toxic properties that can be found in New Zealand – in back yards, public gardens, school playgrounds, on roadsides and in waste ground.

With a particular focus on plants that are of concern for children, the emphasis is on safety through education, to help you understand the risks so that you can avoid them. There is advice on what to do if you think you or your child has eaten something poisonous and a section on toxic mechanisms – how the poisons act on the human body, the signs and symptoms of poisoning, and the treatment likely to be necessary.

Enlivened with historical background and interesting folklore, and comprehensively illustrated with colour photographs to aid identification, this book provides a practical and measured response to demand for information about poisonous plants in New Zealand."

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OCCURRENCE OF ANISOPHYLLY AND ANISOCLADY WITHIN THE AMARANTHACEAE

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ABSTRACT

Anisophylly and anisoclady, features considered rare in the Amaranthaceae, were observed within some members of the subfamily Gomphrenoideae (Amaranthaceae) during collection of specimens for molecular phylogenetic analysis. Phyllotaxy, equality of leaf size in opposite leaves at a single node, and branching pattern were surveyed within the family to determine their occurrence and potential taxonomic utility. Taxonomic occurrence of anisophylly and anisoclady within Amaranthaceae and the potential significance of their presence are discussed.

RESUMEN

La anisofilia y la anisocladia, características consideradas raras en las Amaranthaceae, fueron observadas en algunos miembros de la subfamilia Gomphrenoideae (Amaranthaceae) durante la recolección de especímenes para análisis filogenéticos moleculares. Se estudió la filotaxis, igualdad de tamaño en hojas opuestas en un nudo, y patrón de ramificación en la familia para determinar su presencia y su potencial utilidad taxonómica. Se discute la presencia de anisofilia y anisocladia en las Amaranthaceae y el significado potencial de su presencia.

INTRODUCTION

Anisophylly refers to the insertion of leaves of different sizes along a stem. The anisophyllous condition is often found on stems exhibiting plagiotropy (horizontal growth) and anisoclady, the differential development of axillary buds along a stem (Dengler 1999). Anisophylly is prevalent among tropical plant families with a decussate leaf arrangement (e.g., Acanthaceae, Gesneriaceae, Melastomataceae, Rubiaceae, and Urticaceae) as well as among some temperate trees such as *Acer* L. and *Populus* L. (Sanchez-Burgos & Dengler 1988; Dengler 1999).

The Amaranthaceae s.s. is a primarily tropical family of flowering plants consisting of approximately 69 genera and 1,000 species classified in the Caryophyllales (Townsend 1993). Morphologically, the Amaranthaceae is sister to the Chenopodiaceae with which it shares numerous morphological characteristics (Kühn 1993; Townsend 1993; Kadereit et al. 2003; Pratt 2003; Müller & Borsch 2005). Molecular-based phylogenetic studies of the Caryophyllales have shown the Chenopodiaceae-Amaranthaceae alliance to be monophyletic (Manhart & Rettig 1994; Downie et al. 1997; Cuénoud et al. 2002; Pratt 2003; Kadereit et al. 2003; Müller & Borsch 2005). Phylogenetic studies with a large sampling of both Amaranthaceae and Chenopodiaceae support a monophyletic Amaranthaceae within a paraphyletic Chenopodiaceae (Cuénoud et al. 2002; Pratt 2003; Kadereit et al. 2003; Müller & Borsch 2005). The Angiosperm Phylogeny Group (APG) (2003) formally recognized a single family under the name Amaranthaceae for this alliance. For the purpose of this paper, however, we will refer to Amaranthaceae in the strict sense.

The Amaranthaceae has traditionally been divided into two subfamilies (Schinz 1934; Townsend 1993), Amaranthoideae and Gomphrenoideae, based on anther locule number (Table 1). The Amaranthoideae has been further divided into tribes and subtribes (Schinz 1934; Townsend 1993) based on ovule number (Table 1). Phyllotaxy is variable within the Amaranthaceae (Table 1) but alternate leaves are diagnostic for Celosieae

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TABLE 1. Morphological characters of the subfamilies, tribes, and subtribes of Amaranthaceae.

	Anther locules	Ovule Number	Phyllotaxy
Amaranthoideae	4	1–many	Alternate/Opposite
Celosieae	4	many	Alternate
Amarantheae	4	1	Alternate/Opposite
Amaranthinae	4	1	Alternate
Aervinae	4	1	Alternate/Opposite
Gomphrenoideae	2	1	Opposite
Pseudoplantageae	2	1	Opposite
Gomphreneae	2	1	Opposite
Froelichiinae	2	1	Opposite
Gomphreninae	2	1	Opposite

and Amaranthinae in the Amaranthoideae whereas opposite, decussately arranged leaves are diagnostic for Gomphrenoideae (Townsend 1993). The character is polymorphic within Aervinae, occasionally being polymorphic within a population of a single species (Townsend 1993).

While collecting Amaranthaceae in Texas for molecular phylogenetic research on the Chenopodiaceae-Amaranthaceae alliance, it was noted that several genera of Gomphrenoideae (e.g., *Guilleminea* Kunth, *Tidestromia* Standl., and *Alternanthera* Forssk.) appeared to have alternate leaves, an unexpected condition within the subfamily. Further examination of the collected specimens revealed that the taxa in question have opposite leaves, but that the taxa superficially appear alternate-leaved due to a combination of anisophylly and anisoclady. A morphological survey of the family was conducted to determine the prevalence, phylogenetic distribution, and potential significance of these characters within the Amaranthaceae.

MATERIALS AND METHODS

Taxon Sampling.—Herbarium specimens from 24 genera and 52 species of the Amaranthaceae, including members of both subfamilies and all tribes except the monotypic Pseudoplantageae (Gomphrenoideae), were surveyed. Both subtribes of Amarantheae were also sampled. Multiple species were sampled from *Charpentiera* Gaudich and the large genera *Alternanthera, Amaranthus* L., *Gomphrena* L., *Iresine* P. Browne, and *Pfaffia* C. Mart. (Table 2).

Character Sampling.—Phyllotaxy, equality of leaf size between a pair of leaves at a single node, and branching pattern were examined directly from herbarium specimens using a dissecting scope and a modified Pohl's solution (Pratt & Clark 2001) where necessary as follows (Table 3).

- Phyllotaxy was examined from all taxa and recorded as alternate or opposite.
- Equality of leaf size at a single node is inapplicable to alternate-leafed taxa, and was examined only for opposite-leafed taxa. Leaf equality was recorded as isophyllous when both leaves of a pair at a node were of equal size, or as anisophyllous when one leaf of the pair was larger and better developed than the second.

  Leaf equality was quantified by measuring the lengths of leaf pairs from three nodes and calculating the size ratio using the average leaf sizes in opposite-leaved taxa using herbarium specimens (ASTC, ISC, and MO) or digitized computer images (GH, K, and NY). Measurements on digitized images were made only when leaf pairs were unambiguous, a situation that was difficult to measure on anisophyllous taxa. The length ratios were calculated (Table 4) and analyzed using t-Tests assuming both equal and unequal variances with JMP 8.0.1 statistical software (SAS 2002).
- Branching pattern was observed from all taxa and recorded as either isocladic or anisocladic. In taxa bearing opposite leaves, anisocladic branching was recorded for those taxa in which only one bud at a node developed into a branch. Isocladic branching was recorded when both buds at a node developed into branches.

Table 2. Specimens examined. ASTC= Stephen F. Austin State University Herbarium, BPM= Borsch, Pratt, and Müller, GH= Gray Herbarium, ISC= Iowa State Ada Hayden Herbarium, K= Kew Botanical Garden, MO= Missouri Botanical Garden Herbarium, NY= New York Botanical Garden. Numbers in parentheses indicate number of genera/species per indicated taxon (Townsend 1993)

Taxon	Location, collector name and number, herbarium
Amaranthaceae (69/780)	
Amaranthoideae (55/409)	
Amarantheae (50/333)	
Amaranthinae (12/92)	
Amaranthus blitoides S. Wats.	Ames, Iowa, *Pratt 200* (ISC)
Amaranthus retroflexus L.	Ames, Iowa, *Pratt 199* (ISC)
Bosea yervamora L.	Canary Islands, *Kunkel 12484* (MO); Canary Islands, *Bramwell 1326* (MO)
Chamissoa altissima (Jacq.) Kunth	Bolivia, *Nee 40597* (ISC)
Charpentiera obovata Gaud.	Oahu, Hawaii, *Perlman & Lau 6125* (MO)
Charpentiera ovata Gaud.	Maui, Hawaii, *Sohmer 6594* (MO)
Aervinae (38/241)	
Achyranthes bidentata Blume	Ames, Iowa, *Pratt 201* (ISC)
Aerva javonica (Burm. F.) Juss.	Pakistan, *Ajab & Ashraf 1254* (MO)
Calicorema capitata (Moq.) Hook.f.	South West Africa, *Giess, Volk, & Bleissner 6206* (MO)
Nototrichium humile Hillebr.	Oahu, Hawaii, *Degener s.n.* (ISC)
Pandiaka heudelotii (Moq.) Benth. & Hook.	Burundi, *Lambinon 78/84* (MO)
Ptilotus obovatus (Gaudich.) F. Muell.	Australia, *Conn 2285* (MO)
Pupalia lappacea (L.) Juss.	Ghana, *Schmidt, Amponsah, & Welsing 1881* (MO)
Celosieae (5/76)	
Celosia argentea L.	Ames, Iowa, *Pratt 222* (ISC)
Deeringia polysperma (Roxb.) Moq.	Taiwan, *Shu-Hui Wu 1153* (MO)
Hermbstaedtia glauca Moq.	South Africa, *Esterhuysen 240* (MO)
Pleuropetalum sprucei (Hook. F.) Standley	Costa Rica, *Jiménez & Soto 981* (MO); Costa Rica, *Haber & Zuchowski 9397* (MO)
Gomphrenoideae (36/371)	
Alternanthera albida (Moq.) Griseb.	Argentina, *s.c. s.n.* (K)
Alternanthera areqipense Suess.	Arequipa, Peru, *Pennell 13131* (NY)
Alternanthera bettzickiana (Regel) Standl.	Nacogdoches, Texas, *Banks 2046* (ASTC)
Alternanthera brasiliana (L.) Kuntze	Brazil, *Tsugaru & Sano B-223* (NY)
Alternanthera caracasana Kunth	Alpine, Texas, *BPM 3433* (ISC)
Alternanthera ficoidea (L.) R. Br.	Puerto Rico, *Luquillo, Liogier & Liogier 31898* (NY)
Alternanthera morongii Rusby	Asuncion, Paraguay, *Morong 40* (NY)
Alternanthera philoxeroides (Mart.) Griseb.	Chamber Co, Texas, *Jones 1623* (ASTC)
Alternanthera polygonoides (L.) R. Br.	Montgomery Co, Texas, *Raines 258* (ASTC)
Alternanthera pungens Kunth	Carlsbad, New Mexico, *BPM 3449* (ISC)
Alternanthera repens (L.) Kuntze	Hamilton, Texas, *Stanford 1337* (ASTC)
Alternanthera sessilis (L.) R. Br. ex DC.	Concordia Parish, Louisiana, *Thomas, Martin, Scarborough, & Slaughter 106,565* (ASTC)
Alternanthera tenella Colla	St. John, Virgin Islands, *Acevedo-Rodriguez et al. 2913* (NY)
Blutaparon vermicularis (L.) Mears	South Padre Island, Texas, *BPM 3444* (ISC)
Froelichia floridana (Nutt.) Moq.	Mcintosh Co., Georgia, *Duncan 20458* (ISC)
Gomphrena albiflora Moq.	Colombia, *Dawe 527* (K)
Gomphrena arborescens L.f.	Mato Grosso do Sul, Brazil, *Lindman A2497* (NY)
Gomphrena globosa L.	Ames, Iowa, *Pratt 228* (ISC)
Gomphrena lutea Rusby	Ixiamus, Bolivia, *Cardenas 1911* (NY)
Gomphrena pungens Seub.	Minas Gerais, Brazil, *Pirani et al. CRCR8686* (NY)
Gomphrena serrata L.	St. Thomas University, Virgin Islands, *Acevedo-Rodriguez 11372* (NY)
Gomphrena silenoides Chodat	Paraguay, *Hassler 7491* (NY)

TABLE 2. *continued*

Taxon	Location, collector name and number, herbarium
Guilleminea densa (Humb. & Bonpl.) Moq.	Alpine, Texas, *BPM 3434* (ISC)
Gossypianthus lanuginosa (Poir.) Moq.	Tarrant Co., Texas, *Ruth 977* (ISC)
Iresine alternifolia S. Watson	Sonora, Mexico, *Palmer 276* (GH)
Iresine angustifolia Euphrasen	St. John, Virgin Islands, *Acevedo-Rodriguez 2568* (NY)
Iresine argentata (Mart.) D. Dietr.	Coamo, Puerto Rico, *Britton & Britton 9032* (NY)
Iresine diffusa Humb. & Bonpl. ex Willd. var *spiculigera* Eliasson	St. Maarten, Netherlands *Antilles, Mori 26444* (NY)
Iresine grandis Standl.	San Luis Potosi, Mexico, *Pringle 3962* (NY)
Iresine leptoclada (Hook. f.) Henrickson & Sundberg	El Paso, Texas, *Wright 589* (GH)
Iresine orientalis G.L. Nesom	Nuevo Leon, Mexico, *Palmer 1133* (NY)
Pfaffia acutifolia (Moq.) Stutzer	Brazil, *Gardner 2294* (K)
Pfaffia eriocephala Suess.	Neguange, Colombia, *Smith 2095* (NY)
Pfaffia townsendii Pedersen	Goias, Brazil, *Irwin 12611* (NY)
Tidestromia lanuginosa (Nutt.) Standley	Mustang Island, Texas, *BPM 3459* (ISC)

RESULTS

Phyllotaxy.—Phyllotaxy is variable within the family, which possesses both alternate- and opposite-leaved taxa. Within Amaranthoideae, all members of tribe Celosieae and subtribe Amaranthinae were observed to have alternate leaves, however subtribe Aervineae is polymorphic for phyllotaxy, having both alternate- and opposite-leafed taxa. All members of the Gomphrenoideae were observed to have opposite leaves (Table 3).

Leaf Equality.—Anisophylly was observed to occur in some opposite-leaved taxa of Gomphrenoideae (Table 3). One genus, *Alternanthera*, was observed to be polymorphic for isophylly/anisophylly (Table 3). The average leaf length ratio of leaf pairs at a node in isophyllous taxa was 0.94: 1, while the average leaf length ratio of leaf pairs at a node in anisophyllous taxa was 0.59: 1 (Table 4). Inequality of leaves is thus extremely pronounced, with one leaf of a pair measuring nearly twice the size of the second. Two-sample t-Tests were statistically significant at $p< 0.0001$, assuming both equal (DF=31) and unequal (DF= 8.48) variances.

Branching Pattern.—Primary and higher order branching was isocladic in all alternate-leaved taxa. Branching pattern in opposite-leaved taxa was variable, with both isocladic and anisocladic branching patterns occurring within the Gomphrenoideae. Anisocladic branching in opposite-leaved taxa was observed only in taxa with anisophyllous leaves (Table 3). One genus, *Alternanthera*, was polymorphic for branching pattern (Table 3).

Buds developing into branches in anisocladic taxa were always subtended by the larger leaf of the anisophyllous leaf pair. These lateral branches in turn bore opposite, anisophyllous leaves and inflorescences, and could also bear secondary and higher order branches (Fig. 1). Secondary and higher order branches also follow the pattern of anisoclady, as these branches are also subtended by the larger leaf of an anisophyllous leaf pair. Taxa exhibiting anisophylly and anisoclady superficially resemble an alternate phyllotaxy as the larger leaves and their associated branches alternate sides along the axis of the stem (Fig. 1).

DISCUSSION

Anisophylly and anisoclady are fairly common character states within subfamily Gomphrenoideae. Character-state optimizations of phyllotaxy on an independently derived phylogeny based on plastid *ndhF* gene sequence data (Pratt 2003) show that the character has undergone several transitions. Unfortunately, the presence of these states has rarely been noted in the literature, except for the genera *Guilleminea* and *Gossypianthus* Hook. (Henrickson 1987, see especially figures1 A–B and 2 A–C; see also the illustrations in Roberston and Clemants 2003 for *Alternanthera caracasana*, *Guilleminea*, and *Gossypianthus*), nor have the characters been

Table 3. Phyllotaxy, Leaf equality, and Branching in Amaranthaceae. n/a= non-applicable.

	Phyllotaxy	Leaf Equality	Branching
Amaranthoideae-Amarantheae-Amaranthineae			
Amaranthus blitoides	Alternate	n/a	Isocladic
Amaranthus retroflexus	Alternate	n/a	Isocladic
Bosea yervamora	Alternate	n/a	Isocladic
Chamissoa altissima	Alternate	n/a	Isocladic
Charpentiera obovata	Alternate	n/a	Isocladic
Charpentiera ovata	Alternate	n/a	Isocladic
Amaranthoideae-Amarantheae-Aervineae			
Achyranthes bidentata	Opposite	Isophyllous	Isocladic
Aerva javonica	Alternate	n/a	Isocladic
Calicorema capitulata	Alternate	n/a	Isocladic
Nototrichium humile	Opposite	Isophyllous	Isocladic
Pandiaka heudelotii	Opposite	Isophyllous	Isocladic
Ptilotus obovatus	Alternate	n/a	Isocladic
Pupalia lappacea	Opposite	Isophyllous	Isocladic
Amaranthoideae-Celosieae			
Celosia argentea	Alternate	n/a	Isocladic
Deeringia polysperma	Alternate	n/a	Isocladic
Hermbstaedtia glauca	Alternate	n/a	Isocladic
Pleuropetalum sprucei	Alternate	n/a	Isocladic
Gomphrenoideae			
Alternanthera albida	Opposite	Isophyllous	Isocladic
Alternanthera areqipense	Opposite	Isophyllous	Isocladic
Alternanthera bettzickiana	Opposite	Isophyllous	Isocladic
Alternanthera brasiliana	Opposite	Isophyllous	Isocladic
Alternanthera caracasana	Opposite	Anisophyllous	Anisocladic
Alternanthera ficoidea	Opposite	Isophyllous	Isocladic
Alternanthera morongii	Opposite	Anisophyllous	Anisocladic
Alternanthera philoxeroides	Opposite	Isophyllous	Isocladic
Alternanthera polygonoides	Opposite	Isophyllous	Isocladic
Alternanthera pungens	Opposite	Anisophyllous	Anisocladic
Alternanthera repens	Opposite	Anisophyllous	Anisocladic
Alternanthera sessilis	Opposite	Isophyllous	Isocladic
Alternanthera tenella	Opposite	Anisophyllous	Anisocladic
Blutaparon vermicularis	Opposite	Isophyllous	Isocladic
Froelichia floridana	Opposite	Isophyllous	Isocladic
Gomphrena albiflora	Opposite	Isophyllous	Isocladic
Gomphrena arborescens	Opposite	Isophyllous	Isocladic
Gomphrena globosa	Opposite	Isophyllous	Isocladic
Gomphrena lutea	Opposite	Isophyllous	Isocladic
Gomphrena pungens	Opposite	Isophyllous	Isocladic
Gomphrena serrata	Opposite	Isophyllous	Isocladic
Gomphrena silenoides	Opposite	Isophyllous	Isocladic
Gossypianthus lanuginosa	Opposite	Anisophyllous	Anisocladic
Guilleminea densa	Opposite	Anisophyllous	Anisocladic
Iresine alternifolia	Alternate	na	Isocladic
Iresine angustifolia	Opposite	Isophyllous	Isocladic
Iresine argentata	Opposite	Isophyllous	Isocladic
Iresine diffusa	Opposite	Isophyllous	Isocladic
Iresine grandis	Opposite	Isophyllous	Isocladic
Iresine leptoclada	Alternate	na	Isocladic
Iresine orientalis	Opposite	Isophyllous	Isocladic
Pfaffia acutifolia	Opposite	Isophyllous	Isocladic
Pfaffia eriocephala	Opposite	Isophyllous	Isocladic
Pfaffia townsendii	Opposite	Isophyllous	Isocladic
Tidestromia lanuginosa	Opposite	Anisophyllous	Anisocladic

TABLE 4. Leaf length ratios of equal and unequal leaf pairs in Gomphrenoideae.

	Leaf Equality	**Leaf Pair Ratio**
Alternanthera albida	Isophyllous	0.95 : 1
Alternanthera areqipense	Isophyllous	0.99 : 1
Alternanthera bettzickiana	Isophyllous	0.98 : 1
Alternanthera brasiliana	Isophyllous	0.93 : 1
*Alternanthera ficoidea**	Isophyllous	0.93 : 1
Alternanthera philoxeroides	Isophyllous	1.00 : 1
Alternanthera polygonoides	Isophyllous	0.90 : 1
Alternanthera sessilis	Isophyllous	0.98 : 1
Blutaparon vermicularis	Isophyllous	0.92 : 1
Froelichia floridana	Isophyllous	0.93 : 1
Gomphrena albiflora	Isophyllous	0.97 : 1
Gomphrena arborescens	Isophyllous	0.92 : 1
Gomphrena globosa	Isophyllous	0.96 : 1
Gomphrena lutea	Isophyllous	0.89 : 1
Gomphrena pungens	Isophyllous	0.96 : 1
Gomphrena serrata	Isophyllous	0.94 : 1
Gomphrena silenoides	Isophyllous	0.95 : 1
Iresine angustifolia	Isophyllous	0.93 : 1
Iresine argentata	Isophyllous	0.89 : 1
Iresine diffusa	Isophyllous	0.97 : 1
Iresine grandis	Isophyllous	0.96 : 1
Iresine orientalis	Isophyllous	0.96 : 1
Pfaffia acutifolia	Isophyllous	0.86 : 1
Pfaffia eriocephala	Isophyllous	0.90 : 1
Pfaffia townsendii	Isophyllous	0.97 : 1
Average Leaf Ratio	**0.94 : 1**	
Alternanthera caracasana	Anisophyllous	0.59 : 1
Alternanthera morongii	Anisophyllous	0.54 : 1
Alternanthera pungens	Anisophyllous	0.54 : 1
Alternanthera repens	Anisophyllous	0.57 : 1
Alternanthera tenella	Aniosphyllous	0.68 : 1
Gossypianthus lanuginosa	Anisophyllous	0.54 : 1
Guilleminea densa	Anisophyllous	0.69 : 1
Tidestromia lanuginosa	Anisophyllous	0.56 : 1
Average Leaf Ratio	**0.59 : 1**	

*Average was calculated from only two leaf pairs

used in taxonomic treatments, despite the fact that they may be of some taxonomic utility. The unreported, yet widespread presence of anisophylly and anisoclady within the Amaranthaceae was somewhat surprising, but underscores the great need for critical morphological examination of the Amaranthaceae as well as for its sister family the Chenopodiaceae.

Molecular phylogenetic analyses of the Chenopodiaceae-Amaranthaceae alliance (Pratt 2003; Kadereit 2003; Müller & Borsch 2005) have recovered a strongly supported monophyletic Gomphrenoideae. The relationships of the Gomphrenoideae (opposite leaves) with opposite-leaved taxa of the Aervineae are uncertain. Strict consensus places many of the Aervineae as sister to Gomphrenoideae, although relationships with the Aervineae-Gomphrenoideae clade are currently unresolved (Pratt 2003; Kadereit 2003; Müller & Borsch 2005; Sage et al. 2007). Anisophylly and anisoclady were restricted to the Gomphrenoideae in this survey of the Amaranthaceae. Because the characters have been previously unreported, their presence within a taxon cannot be ruled out based on prior literature.

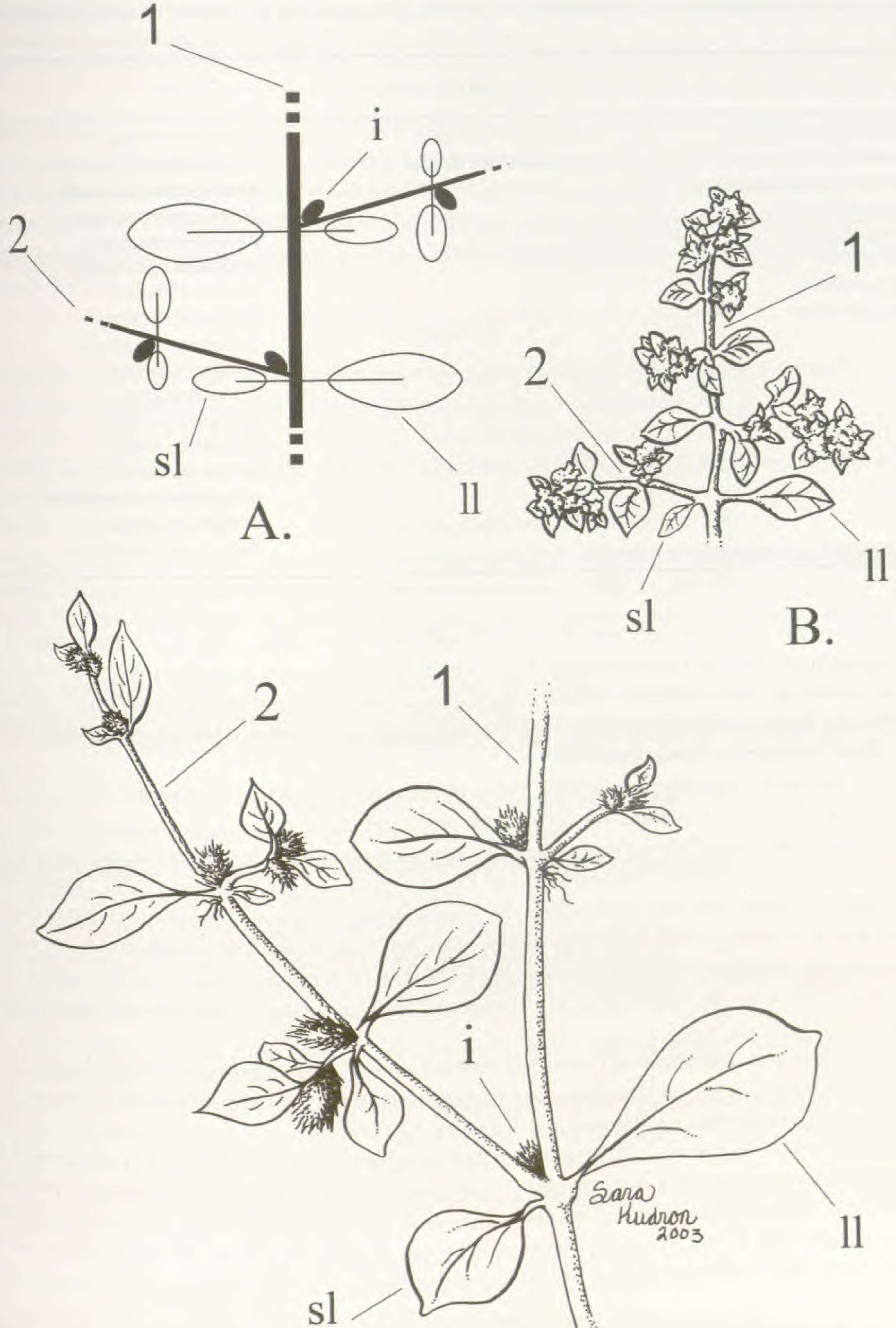
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FIG. 1. Diagrams of anisophylly and anisoclady in Amaranthaceae. **A.** Schematic diagram of anisophylly and anisoclady. **B.** *Guilleminea densa*. **C.** *Alternanthera pungens*. ll= larger leaf; sl= smaller leaf; i= flower or inflorescence; 1= primary stem axis; 2= secondary axis.

Table 5. Leaf position and photosynthetic patterns in Gomphrenoideae. INT= Intermediate photosynthetic pathway, taxa in boldface= taxa exhibiting anisophylly and anisoclady.

C3	INT	C4
Alternanthera bettzickiana	*Alternanthera ficoidea*	*Alternanthera albida*
Alternanthera brasiliana	***Alternanthera tenella***	***Alternanthera caracasana***
Alternanthera philoxeroides		***Alternanthera morongii***
Alternanthera sessilis		***Alternanthera pungens***
Iresine angustifolia		***Alternanthera repens***
Iresine diffusa		*Blutaparon vermicularis*
Pfaffia acutifolia		*Froelichia floridana*
Pfaffia townsendii		*Gomphrena albiflora*
		Gomphrena arborescens
		Gomphrena globosa
		Gomphrena lutea
		Gomphrena pungens
		Gomphrena serrata
		Gomphrena silenoides
		Gossypianthus lanuginosa
		Guilleminea densa
		Tidestromia lanuginosa

Anisophylly and anisoclady may be taxonomically significant both within and among genera of the Gomphrenoideae. Several other characters known to be associated with anisophylly have yet to be investigated including: stem symmetry (radial vs. dorsiventral); pattern of leaf symmetry (*Selaginella* P. Beauv., *Strobilanthus* Rchb., or *Pellionia* Gaudich. types); anatomy; and developmental pattern (see Dengler 1999 for an in depth treatment of these characters).

The literature designates two general types of anisophylly: habitual anisophylly characterized by anisophylly expressed throughout the entire plant body; and lateral anisophylly characterized by an upright, isophyllous, orthocladic primary axis, the expression of anisophylly and anisoclady being limited to plagiotropic lateral shoots (Sanchez-Burgos & Dengler 1988; Morgan & Dengler 1988; Dengler 1999). Both types of anisophylly may occur within the Amaranthaceae. Habitual anisophylly is characteristic of plants with a creeping growth habit (e.g., *Alternanthera p.p.*, *Guilleminea*, and *Gossypianthus*), and tends to be consistently expressed within species (Dengler 1999). Lateral anisophylly may occur among plants with an upright habit (e.g., *Alternanthera p.p.* and *Tidestromia*) and may be environmentally influenced (Dengler 1999).

The presence of anisophylly and anisoclady within Gomphrenoideae appears to be correlated to photosynthetic pathway. The genera here reported to possess the anisophyllous and anisocladic characters (*Alternanthera p.p.*, *Gossypianthus*, *Guilleminea*, and *Tidestromia*) all possess the C_4 photosynthetic pathway (Table 5; Sage et al. 2007). Sage et al. (2007) report that *Alternanthera* is monophyletic and can be subdivided into a monophyletic C_3 clade and a monophyletic C_4 clade and contains a few species exhibiting an intermediate pathway. Photosynthetic pathway is known (Sage et al. 2007) for eleven of the species of *Alternanthera* examined here. All of the C_3 taxa exhibited isophylly and isoclady, one of the two intermediates had the anisophyllous and anisocladic states, and all but one of the C_4 taxa were anisophyllous and anisocladic (Table 5).

The presence of anisophylly and anisoclady within the Gomphrenoideae bears on hypotheses of their adaptive significance. It has been proposed that these characters are adaptations for increasing light gathering potential in forest understory plants, and in the prevention of self-shading (Dengler 1999). However, all of the plants for which anisophylly and anisoclady are herein reported exhibit the C_4 photosynthetic pathway (Sage et al. 2007), and many are native to xeric environments with bright, full sun. Any hypothesis of the adaptive significance of anisophylly and anisoclady within the Gomphrenoideae must also take into account the correlation of these characters with photosynthetic system.

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We thank an anonymous reviewer who provided comments that greatly improved our paper. The authors gratefully acknowledge the Iowa State University Ada Hayden Herbarium (JSC), Herbarium of Kew Gardens (K), Herbarium of the Missouri Botanical Gardens (MO), Gray Herbarium (GH), Herbarium of the New York Botanical Garden (NY), and the Herbarium of the Stephen F. Austin State University Biology Department (ASTC). We also thank our illustrator Ms. Sarah Kudron, and Anna Gardner and Dr. Neal Cox for technical help with the illustrations.

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BOOK REVIEW

John Alcock. 2009. **When the Rains Come: A Naturalist's Year in the Sonoran Desert.** (ISBN 978-0-8165-2762-5, pbk.). University of Arizona Press, 355 S. Euclid Ave., Suite 103, Tucson, Arizona 85719, U.S.A. (**Orders:** www.uapress.arizona.edu, 1-800-426-3797). $21.95, 334 pp., 111 color photographs, 8 1/2" × 9 1/2".

Rather than a day-by-day diary, this is a monthly recording of the weather and its corresponding effects on the flora and fauna of one portion of the Sonoran Desert, specifically the Usery Mountains north of Tempe, Arizona. This is saguaro country, and of creosote bush and paloverde, of Gila monsters and desert horned lizards, of fox and coyote, of innumerable interesting insects, and relatively void of obnoxious human intruders and their destructive livestock. Eighty-eight times during 2006 the author climbed into the mountains in drought and searing heat or in nipping winter winds. He watched the development of young saguaros—and sometimes their demise. He anticipated when male wasps would hilltop to await the females and observed their activities. Along the way he tells the reader of other facets of desert life, that is, life in the extreme conditions of heat and drought, seasonal changes dramatic in their own low-keyed way.

The photographs are superb, adding to the reader's pleasure in accompanying the author into the desert. The work would have been enhanced by a list of plants by the vernacular and scientific names. The binomials are given for most insects but not for most plants neither in the text nor in the index. Otherwise the book is excellent reading for both scientist and general reader.—*Joann Karges, Texas Christian University Library (retired), Fort Worth, Texas, U.S.A.*

OBSERVATIONS ON *BUCKLEYA* (THESIACEAE) IN CHINA

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ABSTRACT

Buckleya lanceolata (Siebold & Zucc.) Miquel (Thesiaceae) from Japan and *B. henryi* Diels from China have been recognized as distinct species since *B. henryi* was described in 1908. Characters to separate them have neither been questioned nor analyzed in detail. Separation of the two species has most likely been based on geography as much as, if not more than, morphological features. During a class field trip with students from Zhejiang University, Hangzhou, and North Carolina State University, Raleigh, North Carolina, in 2008 we visited a number of sites in southern Anhui and Zhejiang provinces, China. Among the collections made on Qiyun Shan, Xiuning Xian, Anhui, was a most interesting shrub of the genus *Buckleya* (Thesiaceae), which we later determined to be *B. angulosa* S.B. Zhou & X.H. Guo. Based on our observations of specimens of *Buckleya* in the Harvard University Herbaria, we discovered that *B. angulosa* shares characteristics of both the Chinese *B. henryi* and the Japanese *B. lanceolata*. Similarities and differences among these taxa are discussed and the possibility of paleo hybridization is raised.

CHINESE ABSTRACT

摘要：自1908年*Buckleya henryi* Diels发表以来，中国分布的*B. henryi*与日本分布的*B. lanceolata* (Siebold & Zucc.) Miquel一 直被认为是2个不同的种，但二者分类特征的可靠性尚未有人怀疑或深入分析。这两个种的成立很可能是由于地理分布和形态的差异。今年我们在安徽休宁县齐云山的植物学野外实习中，发现了米面蓊属一种非常有意思的植物，即最近发表的棱果米面蓊（*B. angulosa* S.B. Zhou & X.H. Guo）通过对哈佛大学标本馆（A）米面蓊属标本的观察，我们发现毛被和叶形并非*B. henryi* 和*B. lanceolata*的可靠分类依据；棱果米面蓊分别具有中国分布的 *B. henryi*与日本分布的 *B. lanceolata* 的特征。本文对这些种形态特征的异同进行了讨论，推测棱果米面蓊可能是 *B. henryi* 和 *B. lanceolata* 的杂交后代。关键词：米面蓊属；檀香科；分类；系统发育；远古杂交

Key Words: *Buckleya*, Thesiaceae (Santalaceae), China, taxonomy, phylogeny, paleo hybridization

During a class field trip in 2008 with students from Zhejiang University, Hangzhou, China, and North Carolina State University, Raleigh, North Carolina, U.S.A., we visited a number of sites in southern Anhui and in Zhejiang provinces. One of the most floristically interesting areas was Qiyun Shan, in Xiuning Xian, Anhui Province. Among the rich assemblage of plants on Qiyun Shan, was a most interesting shrub of the genus *Buckleya* Torr. (Thesiaceae. Although *Buckleya* has been placed traditionally in the Santalaceae, it will be placed in Thesiaceae by D. Nickrent (manuscript submitted) in the forthcoming treatment of the genus in the *Flora of North America*; also Nickrent et al. in press).

Upon returning to the United States, the collection of *Buckleya* from Qiyun Shan was compared with specimens of *B. lanceolata* (Siebold & Zucc.) Miquel (Fig. 1) from Japan and with specimens of *B. henryi* Diels from China, since it did not fit descriptions in the monograph by Carvell and Eshbaugh (1982) or any of the species of *Buckleya* in the *Flora of China* (Xia & Gilbert 2003). The plants from Qiyun Shan resembled the Japanese *B. lanceolata* in the longitudinal grooves of the mature fruit and in the broader and somewhat caudate-acuminate leaves, but they resembled *B. henryi* in having terminal and axillary inflorescences. *Buckleya lanceolata* from Japan has only terminal inflorescences, but *B. henryi* from China sometimes produces both axillary and terminal inflorescences (Carvell & Eshbaugh 1982). The trichomes of *B. lanceolata* are reported

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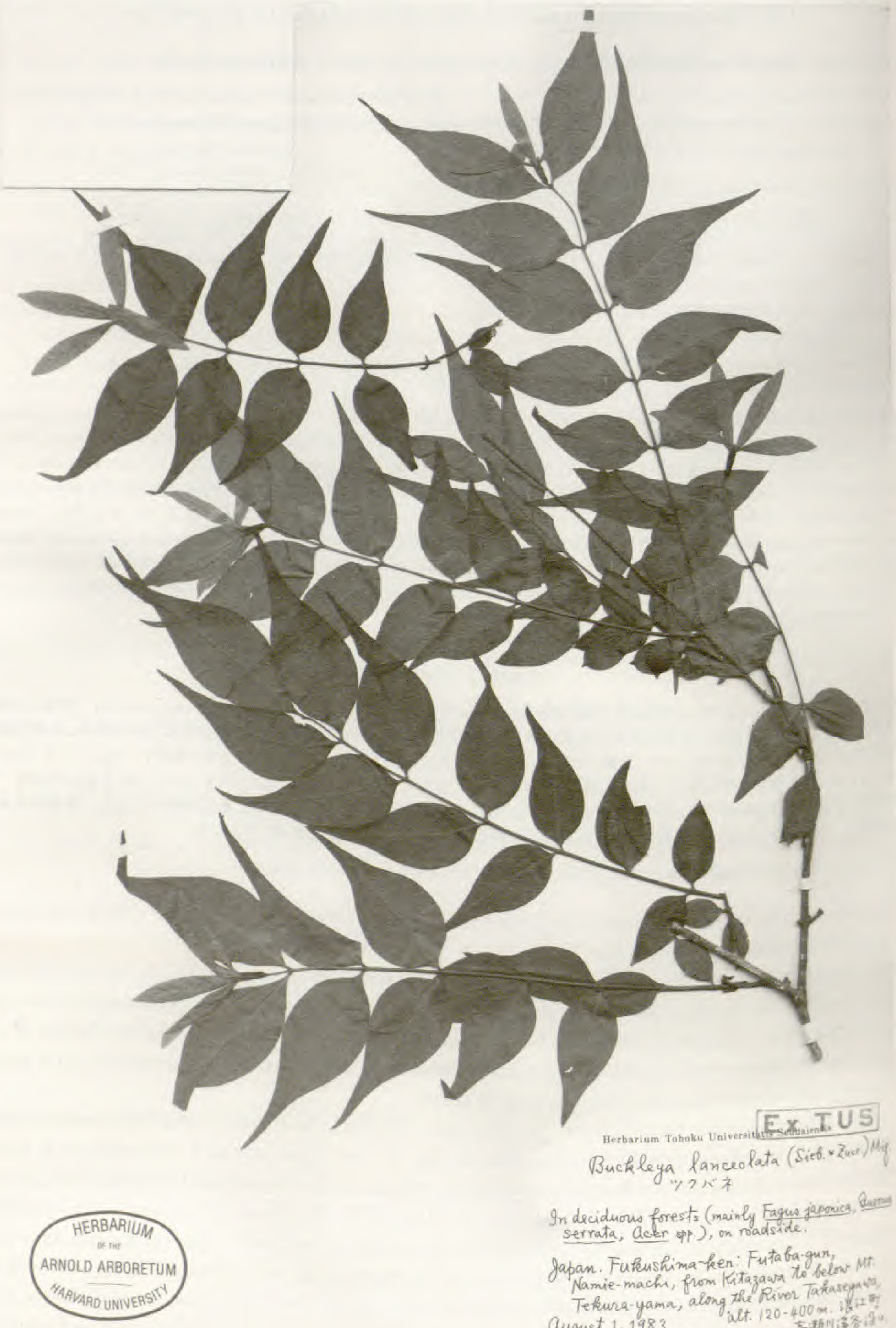

Ex. TUS
Herbarium Tohoku Universitatis Sendaiensis
Buckleya lanceolata (Sieb. & Zucc.) Miq.
ツクバネ
In deciduous forests (mainly Fagus japonica, Quercus serrata, Acer spp.), on roadside.
Japan. Fukushima-ken: Futaba-gun, Namie-machi, from Kitazawa to below Mt. Tekura-yama, along the River Takasegawa, alt. 120-400 m.
浪江町 高瀬川渓谷沿い 北沢ー手倉山下
August 1, 1983
Leg. H. Ohashi & Y. Ueno 8557
HERBARIUM OF THE ARNOLD ARBORETUM HARVARD UNIVERSITY

Fig. 1. ***Buckleya lanceolata*** **(Siebold & Zucc.) Miquel. Specimen collected in Japan, Fukushima Prefecture, Futaba-gun, Namie-machi, along the Takase River, *H. Ohashi & Y. Uena 8557* (A). Note similarity of leaves and flowers in Figs. 1 and 2.**

to be both uniseriate and multicellular while *B. henryi* has minute conical and/or papillate trichomes ("hairs") on the vegetative parts (Carvell and Eshbaugh, 1982). Some specimens of *B. lanceolata* from Japan, however, do not have the long trichomes, for example, *H. Ohashi & Y. Ueno 8557* (A) from along the Takase River in Namie-machi, Futaba-gun in Fukushima Prefecture. In fact, the *Ohashi & Ueno* specimen, collected north of Tokyo, closely resembles our Anhui collections vegetatively. In many ways the plants of *Buckleya* from Anhui appear to be hybrids between the Japanese *B. lanceolata* and the Chinese *B. henryi*. After making these observations we became aware that plants from Tianzhu Shan, Anhui, and matching the characteristics of our find on Qiyun Shan, were described and named *B. angulosa* by S.B. Zhou & X.H. Guo (2004).

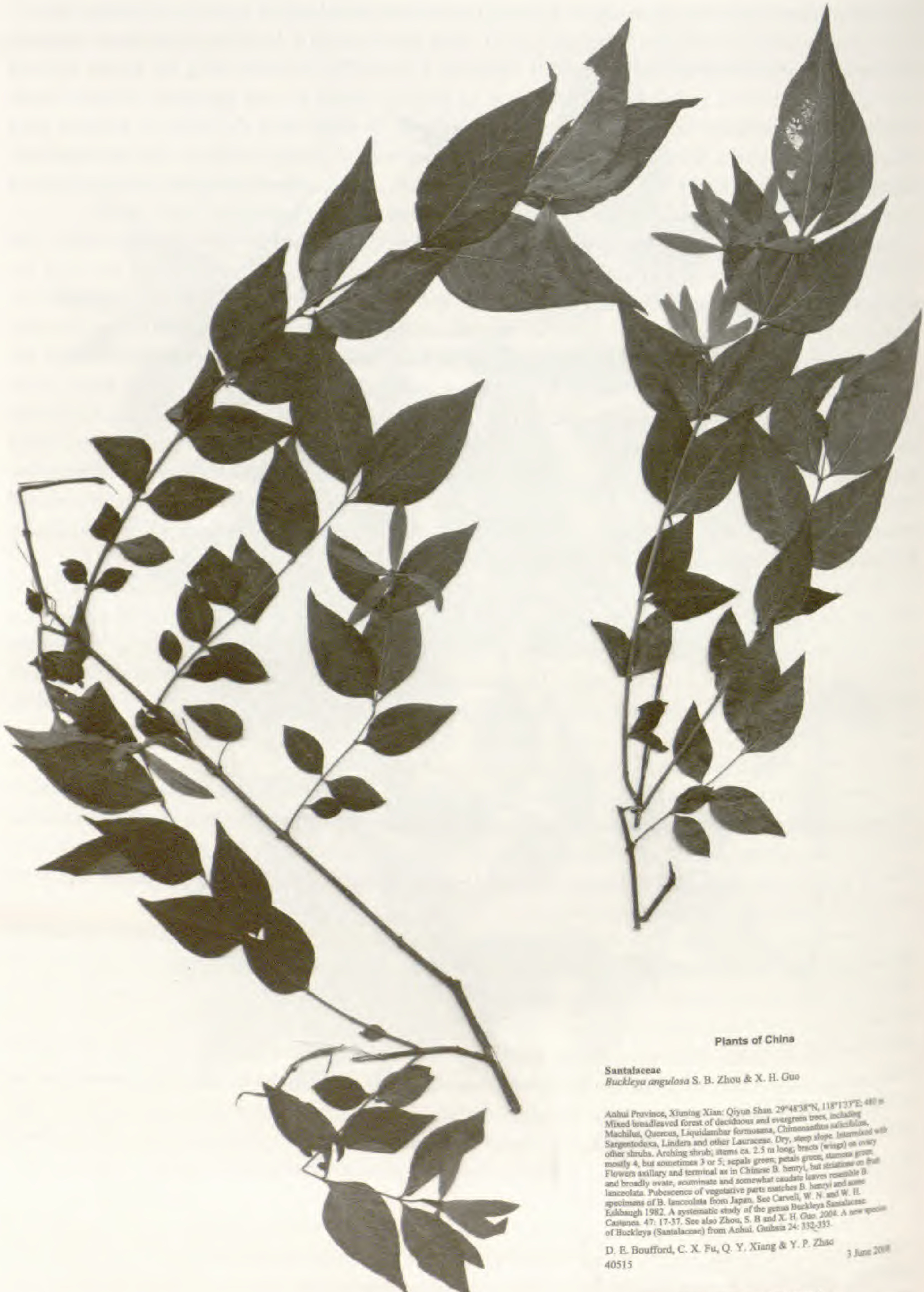
Housed in the Harvard University Herbaria (A, GH) are other specimens from southern Anhui that resemble the plants we saw in the field. Specimens of *Buckleya* from farther north in Henan and from the Qinling (and Funyu) Mountains, however, have more slender, elliptic leaves and the fruiting sepals are smaller, but at a quick glance and without careful measurements, both characters appear to be variable. The plants from Anhui have leaves that are broader toward the base, or at least below the middle, and the apex is acuminate-caudate, but not as obviously acuminate-caudate as in *B. lanceolata* from Japan. Most plants of *B. lanceolata* have uniseriate, multicellular trichomes on the vegetative parts, particularly near the base on the lower surface of the leaves, plus minute conical projections (trichomes). *Buckleya henryi* lacks multicellular trichomes, but has the minute conical projections. Although the plants from Anhui resemble the Chinese *B. henryi* in pubescence, several specimens of *B. lanceolata* from Japan also have similarly shaped leaves and similar pubescence. Pubescence and leaf shape are therefore not 100 percent reliable features for distinguishing the species of *Buckleya* in Asia.

The illustration of *Buckleya angulosa* provided by Zhou and Guo (2004) matches our collections (Fig. 2) well in showing the axillary inflorescences and elliptic sepals on the fruit. Although they provide a diagnostic key to separate the Chinese species of *Buckleya*, *B. henryi* is neither mentioned in their key to the species in China nor in the narrative of their paper. The narrowly elliptic leaves in their illustration of *B. angulosa*, however, resemble more closely those of *B. henryi* than they do those of our collection from Qiyun Shan. Our specimens also lack the peculiar apical projection on the leaves, shown in the illustration of Zhou and Guo, and which appear sporadically on all Asian species of *Buckleya*.

Buckleya henryi may not have been considered to be a distinct species by Zhou and Guo (2004), since it was placed in synonymy under *B. lanceolata* by Tam (1988) in the treatment of the genus in *Flora Reipublicae Popularis Sinicae* volume 24. Xia and Gilbert (2003), however, who also recognize two species of *Buckleya* in China, *B. graebneriana* Diels and *B. henryi*, noted in their treatment in the *Flora of China* that *B. henryi* has been confused with the Japanese *B. lanceolata*.

In examining specimens of *Buckleya* from Japan and China, one cannot fail to speculate on how the species might have been treated had they all occurred in China, or all in Japan. Would separate species have been recognized, or even distinct taxa at an infraspecific rank? The characteristics used to separate them are not always clear and considerable plasticity can be seen in leaf shape, pubescence and length of the sepals on the fruit. Although the differences in most individuals of *B. henryi* and *B. lanceolata* can easily distinguish them, careful study is needed to determine if clear, discontinuous distinctions occur in the individuals that seemingly combine characteristics of the two species. Might these seemingly intermediate plants be examples of paleo hybridization where the offspring of crosses between species (*B. henryi* × *B. lanceolata* = *B. angulosa*?) brought together sympatrically during the Pleistocene have maintained themselves on the mainland after the extinction of one of the parents there?

Carvell and Eshbaugh (1982) speculated that plants with both axillary and terminal inflorescences were ancestral in *Buckleya*, with terminal inflorescences being derived. Of the four species recognized by them, they considered *B. henryi* to be most similar to the ancestral form, with *B. lanceolata* being a direct descendent. The molecular analysis by Li et al. (2001) supports the relationships hypothesized by Carvell and Eshbaugh. Now, with the recognition of *B. angulosa* and the complexities it adds to the understanding of this small, but biogeographically interesting and important genus, a comprehensive review of the taxonomy



Plants of China

Santalaceae
Buckleya angulosa S. B. Zhou & X. H. Guo

Anhui Province, Xiuning Xian: Qiyun Shan. 29°48'38"N, 118°13'3"E; 480 m
Mixed broadleaved forest of deciduous and evergreen trees, including
Machilus, Quercus, Liquidambar formosana, Chimonanthus salicifolius,
Sargentodoxa, Lindera and other Lauraceae. Dry, steep slope. Intermixed with
other shrubs. Arching shrub; stems ca. 2.5 m long; bracts (wings) on every
mostly 4, but sometimes 3 or 5; sepals green; petals green; stamens green.
Flowers axillary and terminal as in Chinese B. henryi, but striations on fruit
and broadly ovate, acuminate and somewhat caudate leaves resemble B.
lanceolata. Pubescence of vegetative parts matches B. henryi and some
specimens of B. lanceolata from Japan. See Carvell, W. N. and W. H.
Eshbaugh 1982. A systematic study of the genus Buckleya Santalaceae.
Castanea. 47: 17-37. See also Zhou, S. B and X. H. Guo. 2004. A new species
of Buckleya (Santalaceae) from Anhui. Guihaia 24: 332-333.

D. E. Boufford, C. X. Fu, Q. Y. Xiang & Y. P. Zhao
40515
3 June 2008

Harvard University Herbaria

FIG. 2. *Buckleya angulosa* S.B. Zhou, & X.H. Guo. Specimen collected in China, Anhui, Xiuning Xian, Qiyun Shan, *D.E. Boufford, C.X. Fu, Q.Y. Xiang & Y.P. Zhao 40515* (A).

Table 1. Distinguishing features of the five species of *Buckleya*.

	B. angulosa	***B. distichophylla***	***B. graebneriana***	***B. henryi***	***B. lanceolata***
Leaf shape	Ovate to ovate-lanceolate	Narrowly lanceolate to lanceolate or elliptic	Ovate to widely elliptic	Narrowly lanceolate to lanceolate or elliptic, Infrequently ovate-lanceolate	Widely elliptic to lanceolate to ovate-acuminate or ovate
Leaf apex	Abruptly acuminate to caudate	Narrowly acuminate	Narrowly acuminate or tapering smoothly to apex	Narrowly acuminate or tapering smoothly to apex	Abruptly acuminate-caudate
Leaf base	Cuneate to slightly rounded	Attenuate to slightly rounded	Cuneate to rounded	Attenuate to slightly rounded, rarely narrowly cuneate	Attenuate to slightly rounded
Sepals persistence	Persistent	Deciduous	Persistent	Persistent	Persistent
Sepals: fruit length	1.5–2 × longer than fruit	Sepals absent	1–1.5 × longer than fruit	1–2 × longer than fruit	2–4 × longer than fruit
Inflorescence position (both sexes)	Axillary and terminal	Terminal	Terminal	Axillary and terminal	Terminal
Trichomes	Needle-like, conical and papilla-like	Conical and papilla-like	Needle-like	Conical and papilla-like	Needle-like
Ovary/fruit surface	With longitudinal ribs and narrow grooves	Smooth	Smooth	Smooth-slightly sulcate	With longitudinal ribs and narrow grooves to smooth
Distribution	Eastern China	SE United States	East-central China	East-central China	Japan

and relationships within *Buckleya*, using both traditional field and herbarium studies in combination with modern methods, should be undertaken to resolve the complexity in the genus. *Buckleya distichophylla* (Nutt.) Torr., a rare endemic species of the southern Appalachian Mountains in the southeastern United States (Harper 1947; Musselman 1982; Piehl 1965), should be included in the analysis also, even though it was included in the recent phylogenetic analysis by Li et al. (2001).

To rectify the omission of *B. henryi* in *Flora Reipublicae Popularis Sinicae* and *B. angulosa* in the *Flora of China* treatments, we here provide a key to the three species in China. A comparison of all five species of *Buckleya* to show their distinguishing features is presented in Table 1.

1. Ovary smooth, without ribs and narrow grooves; leaves ovate to widely elliptic, tapering smoothly to the acute to obtuse apex; inflorescences terminal; trichomes needle-like **Buckleya graebneriana**
1. Ovary with longitudinal ribs and narrow grooves; leaves lanceolate to widely ovate or occasionally elliptic, apex acuminate to caudate; inflorescences terminal and axillary; trichomes needle-like, papilla-like and/or conical.
    2. Leaves narrowly lanceolate to lanceolate or elliptic, infrequently ovate-lanceolate; trichomes papilla-like and/or conical **Buckleya henryi**
    2. Leaves ovate to ovate-lanceolate, abruptly acuminate to caudate; trichomes needle-like, conical and papilla-like **Buckleya angulosa**

Label details for our collection of *Buckleya angulosa* are: **CHINA:** Anhui, Xiuning Xian, Qiyun Shan., mixed broadleaved forest of deciduous and evergreen trees, including *Quercus acutissima* Carruthers and *Q. fabri* Hance, *Liquidambar formosana* Hance, *Chimonanthus salicifolius* S.Y. Hu, *Sargentodoxa cuneata* (Oliver) Rehder & E.H. Wilson, *Machilus leptophylla* Hand.-Mazz. & Chun, *Lindera glauca* (Siebold & Zucc.) Blume, *Sassafras tzumu* (Hemsley) Hemsley, *Phoebe sheareri* (Hemsley) Gamble, *Cinnamomum japonicum* Siebold and *Alangium kurzii* Craib (Alangiaceae), 29°48'38"N, 118°1'33"E; 480 m, 3 Jun 2008, *D.E. Boufford, C.X. Fu, Q.Y. Xiang & Y.P. Zhao 40515* (A, NCSC, TI), and *Y.P. Zhao Z080638* (HZU).

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COMMENTS ON A REVISION OF *CELTIS* SUBGENUS *MERTENSIA* (CELTIDACEAE) AND THE RECOGNITION OF *CELTIS PALLIDA*

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ABSTRACT

In 2001 Berg and Dahlberg, in their revision of *Celtis* subgenus *Mertensia*, included the Spiny Hackberry (*Celtis pallida*) within the older named *Celtis ehrenbergiana* (type locality Querétaro, México). The type specimen of *C. ehrenbergiana*, with its single supranodal, curved thorn (not paired, straight, node-bearing thorns), domatia on both the primary and secondary vein axils (not restricted to the primary vein axils), and larger fruit pyrenes, is referable to the widespread *C. iguanaea*. *Celtis pallida* occurs both in the southwest USA-Mexico (type locality Texas) and in southern South America where it occurs with the closely related, but older-named *C. tala*. Characteristics exist to support separation of *C. tala* as a species distinct from *C. pallida*, thus mandating the use of the name *C. pallida* for the southwest North American Spiny Hackberry.

RESUMEN

En su revisión de *Celtis* subgénero *Mertensia*, Berg y Dahlberg (2001) incluyen al granjeno (*Celtis pallida*) dentro del concepto de la especie *Celtis ehrenbergiana* (localidad tipo Querétaro, México), la cual fue descrita con anterioridad. El ejemplar tipo de *C. ehrenbergiana*, con espinas solitarias, supranodales y recurvadas (no en pares, rectas y nodales), domacios en las axilas de las venas primarias y secundarias (no restringidos a las axilas de las venas primarias), y fruto con pirenos más grandes, es asignable a la especie de amplia distribución *C. iguanaea*. *Celtis pallida* habita tanto en el sureste de los Estados Unidos y México (localidad tipo Texas) como en el sur de Sudamérica donde crece con *C. tala*, una especie estrechamente relacionada y con nombre más antiguo. Existen varios caracteres que apoyan la separación de *C. tala* como especie distinta de *C. pallida* y, por lo tanto, este último nombre es el que debe aplicarse al granjeno del suroeste de Norteamérica.

INTRODUCTION

In a revision of *Celtis* subgenus *Mertensia*, Berg and Dahlberg (2001) placed the Spiny Hackberry, *Celtis pallida* Torr., within *Celtis ehrenbergiana* (Klotzsch) Liebm. The new name now occurs frequently on the World Wide Web, and has been accepted by the official U.S. Department of Agriculture "Plants" database (http://plants.usda.gov/) and is beginning to appear in the botanical literature. It is the intention of this paper to demonstrate that *Celtis ehrenbergiana* is a northern derivative of and synonym of the widespread *Celtis iguanaea* (Jacq.) Sarg. and is not conspecific with *C. pallida*. Also, *Celtis pallida* is recognized as a species distinct from the closely related *C. tala* Gilles ex Planch. of Argentina.

Most North American *Celtis* species belong to subgenus *Celtis*, which is characterized by two long, undivided styles per ovary, the absence of nodal thorns or spines, and the absence of domatia (small pocket-like flaps) in some vein axils on the abaxial leaf surfaces. This subgenus is represented in North America north of Mexico by *Celtis laevigata* Willd., *C. lindheimeri* K. Koch, *C. occidentalis* L., *C. reticulata* Torr., *C. tenuifolia* Nutt. (Sherman-Broyles et al. 1997). Subgenus *Mertensia* is largely neotropical, with species characterized by paired styles that are again divided below the tip (i.e., bifurcated styles), having solitary or paired thorns above the nodes, and domatia in the vein axils on the abaxial leaf surface.

Two species from subgenus *Mertensia* also occur in North America. *Celtis iguanaea* is a widespread species occurring in tropical areas from southern South America (Argentina) through Central America into central Mexico, and through much of the Caribbean and is reported from southern Florida in the U.S.D.A. Plants website but not in Flora North America (Sherman-Broyles et al. 1997). The second species is *Celtis pallida* and has an amphitropical distribution from the southwest United States (southeast Arizona, southern New

Mexico, trans-Pecos and south Texas) into central Mexico (Baja California Sur, Sonora, Sinaloa, Chihuahua, Coahuila, Durango, Zacatecas, San Luis Potosí, Nuevo León, Tamaulipas, Querétero, Hidalgo, México, Veracruz, Puebla, Oaxaca, and Chiapas), also in Lee County, Florida, and in South America, in north-central Argentina and adjacent Paraguay (Hunziker & Dottori 1976).

In their revision of *Celtis* subgenus *Mertensia*, Berg and Dahlberg (2001) recognized six species, four restricted to dry or deciduous gallery forests in South America and two occurring in both North and South America. They recognized a very broad, variable and wide-ranging *C. iguanaea* that includes lianas, shrubs and small trees with leaves varying greatly in size, marginal toothing and vestiture. They list 26 heterotypic synonyms for the species, but they recognize four peripheral variants as separate species based on differences in style branches (*C. loxensis* C.C. Berg), vestiture [*C. brasiliensis* (Gardner) Planch., *C. chichape* (Wedd.) Miq. in Mart.], and young-stem coloration (*C. orthocanthos* Planch.) as well as thorn structure etc. (Berg & Dahlberg 2001).

Berg and Dahlberg (2001) placed the more xeric shrubs with smaller leaves into *Celtis ehrenbergiana* (epithet named in 1847) listing 13 heterotypic synonyms of the species, including the South American *C. tala* (1848) and the amphitropically distributed *C. pallida* (1858). It is in this that I disagree with the authors.

CELTIS PALLIDA VS. *CELTIS IGUANAEA*

Celtis pallida is very different from *C. iguanaea*, differing in growth habit, the structure of the supranodal thorns, the distribution of domatia on the lower (abaxial) leaf surface, size and structure of the leaves, and the size of flowering styles, mature fruit and pyrenes.

Celtis pallida is an erect, much-branched shrub with notably zig-zagged stems; stem nodes usually produce a pair of straight, sharp-tipped, divergent, lignified thorns (1–)5–20(–55) mm long directly above the nodes. Thorns over 5(–10) mm long bear 1–3 nodes and the thorn nodes typically develop single or fasciculate leaves or even lateral branches. When the thorns are very long they can have secondary thorns above their axillary leaves and thus may mature into branches. But very short thorns can lack nodes, and thorns can sometimes be solitary above the nodes, and some branches can lack throns altogether. The abaxial domatia are usually restricted to the lower midrib axils with the first pair of secondary veins, and the domatia may become swollen and green in color, and they also sometimes occur in the mid-leaf portion—there are none in the axils of the secondary to tertiary vein axils (except in occasionally very large leaves). Leaves range from entire to crenate-serrate, 10–25(–43) mm in length, 6.5–14(–33) mm in width. Inflorescences are small, axillary dichasial cymes consisting mostly of staminate flowers, with only 1–2 bisexual flowers. The two style bases are flattened, ±1 mm long, to 0.7 mm wide, each producing two equally short, papillate divergent lobes at their tips with the papillae extending down the margins of the broad style bases. Mature fruits are orange, usually 6–7(–8) mm in diameter when dried and have a rounded, white pyrene to 4 mm long with a low, alveolate-reticulate sculpturing.

In contrast, *Celtis iguanaea* can be a tree or shrub with spreading liana-like branches or a liana that typically produces a solitary, sharp-tipped, decurved, woody thorn 2–8(–10) mm long above each node; these are rarely paired, rarely to 25 mm long and when large may rarely bear a leaf and secondary decurved thorn at the tip. Inflorescences often develop at the base of the thorn or from the stem below the thorn base and are considerably larger than those in *C. pallida*. Domatia are often poorly developed at the base of the midrib at the axils of the basal secondary veins, but they occur well up the midrib and also along the paired secondary veins in the outer axils with the tertiary veins (this however, may be a feature of leaf size). Leaves in tropical areas are often oblong, to 100–150 mm long, 45–60+ mm wide, pinnately veined above the base, with caudate tips, cuneate to subcordate bases, entire or crenate-serrate toothed margins, but in drier areas of Mexico they are more ovate to oblong-ovate, (15–)33–100 mm long, (10–)20–50(–85) mm wide, and can be well within the size range of those of *C. pallida*. Leaves can also become thick, coarse, strongly scabrous, and have fewer domatia in arid regions. Styles are similar in structure to those of *C. pallida*, but to 3–4.5 mm in total length. Mature fruit are orange to orange yellow, edible, 7–12 mm in diameter, and when mature the rounded pyrene is white, 5–7 mm long, with irregularly raised margins around the coarse alveolate reticulations.

THE TYPE OF *CELTIS EHRENBERGIANA*

Klotzsch (1847) cited a single collection by C. Ehrenberg in his description of *Momisia ehrenbergiana* Klotzsch, the basionym of *Celtis ehrenbergiana* (*C. Ehrenberg 1114*). The type collection was borrowed from the Berlin Herbarium (B) (Fig. 1). It has Ehrenberg's original label "Arbor seu frutex, ubique in loc. calid. las ajuntas (sic), Montezuma, Jan. 1840, Mexico, *C. Ehrenberg 1114*." (=Tree or shrub, common in warm sites...)

The las ajuntas noted is actually Los Adjuntos, a small mining settlement along the Río Montezuma that separates Querétaro from Hidalgo near a small contemporary village of Maconi, Querétaro, northwest of Zimapán, Hidalgo. The locale is shown on the 1937 map of Querétaro in the Atlas Geográfico de las Estados Unidos Mexicános (Anonymous 1932–1937).

The type specimen of *C. ehrenbergiana* (Fig. 1) is rather sparse, consisting of two branches, no flowers, and one sub-mature fruit in the packet. The leaves are ovate, 27–57 mm long, 22–37 mm wide, rounded, or in one leaf, with an obtuse point at the tip, rounded at the base, subentire to crenate with up to 8 teeth, with veins impressed above, with the mid and secondary and some tertiary veins raised, brownish-yellow, the larger 0.3–0.5 mm wide beneath. The leaves are coarse and thickened (as seen in leaves over a year in age) the blades are hirtellous-hirsute and coarsely scabrous with hairs to 0.2–0.3 mm long (to 0.5 mm long along the leaf margins). There are domatia in the axils of the four secondary veins that branch from the base to upper-mid-section of the midrib, and between the secondary and larger tertiary veins on the abaxial leaf surface. The sub-mature dried fruit measured 10.2 × 8.7 mm, the immature pyrene is estimated to be ± 5 mm in diameter. Only one thorn can be seen on the specimen, this on the shorter branch, and it is solitary, strongly decurved, ± 3 mm long, but the tip has been broken off (Fig 1B).

The upper epidermis of the type of *C. ehrenbergiana* has a very bullate appearance in part due to the cystoliths, but the epidermal cells can be seen with 40× magnification and they have a distinctive radiating pattern from the base of the erect, stiff hairs. This pattern is not found on all specimens, particularly those with young, thin leaves, but I have found several other Mexican specimens with the same epidermal pattern. All of these specimens have been placed within *C. iguanaea* based on other characteristics, with the single curved thorn being the best character to distinguish the species from *C. pallida*.

The TEX-LL herbaria has many specimens of *Celtis* from central Mexico (Veracruz, México, Morelos, Hidalgo and San Luis Potosí) that have leaves of the same general size and shape, with crenate leaf margins, and that have curved non-node-bearing thorns, and large fruit like those of the type of *C. ehrenbergiana*. The type of *C. ehrenbergiana* is not an isolated specimen, rather is representative of populations of the drier portions of interior Mexico.

I visited the Los Adjuntos site in June of 2004 to collect the *Celtis* species in the area. The Los Adjuntos area has low xeric subtropical scrub, strongly disturbed fields, pastures and disturbed woodlands with *Acacia farnesiana*, *Mimosa spp.*, *Neopringlea*, *Karwinskia*, *Colubrina*, *Vallesia glabra*, *Capparis incana*, *Maclura tinctoria*, etc. *Celtis pallida* (*Henrickson 23639*, TEX) was frequent in disturbed open areas. We then went back into the mountains and came down another road that crosses the Río Montezuma about 18 km to the south at Presa de Zimapán (which forms Laguna de Zimapán) on a road that leads to Zimapán, Hidalgo. Just east of the dam, we again found shrubs of *Celtis pallida* (*Henrickson 23648*, TEX) and further on a second species *Celtis caudata* Planch. (*Henrickson 23645*, TEX) of subgenus *Celtis*. No specimens similar to the type of *C. ehrenbergiana* were found on the trip. However, it can be stated that *C. pallida* near type locality of *C. ehrenbergiana* is characterized by paired nodal thorns bearing nodes, small leaves with domatia only along the midrib and other character-states typical of *C. pallida* elsewhere and it does not look anything like the type of *C. ehrenbergiana* near its type locality. On the other hand, the type of *C. ehrenbergiana* clearly must be considered a dryland phase of *C. iguanaea*, based on the diagnostic character-states shared with that species.

Therefore *Celtis ehrenbergiana* (Klotzsch) Liebm. 1851 (based on *Momisia ehrenbergiana* Klotzsch 1847)

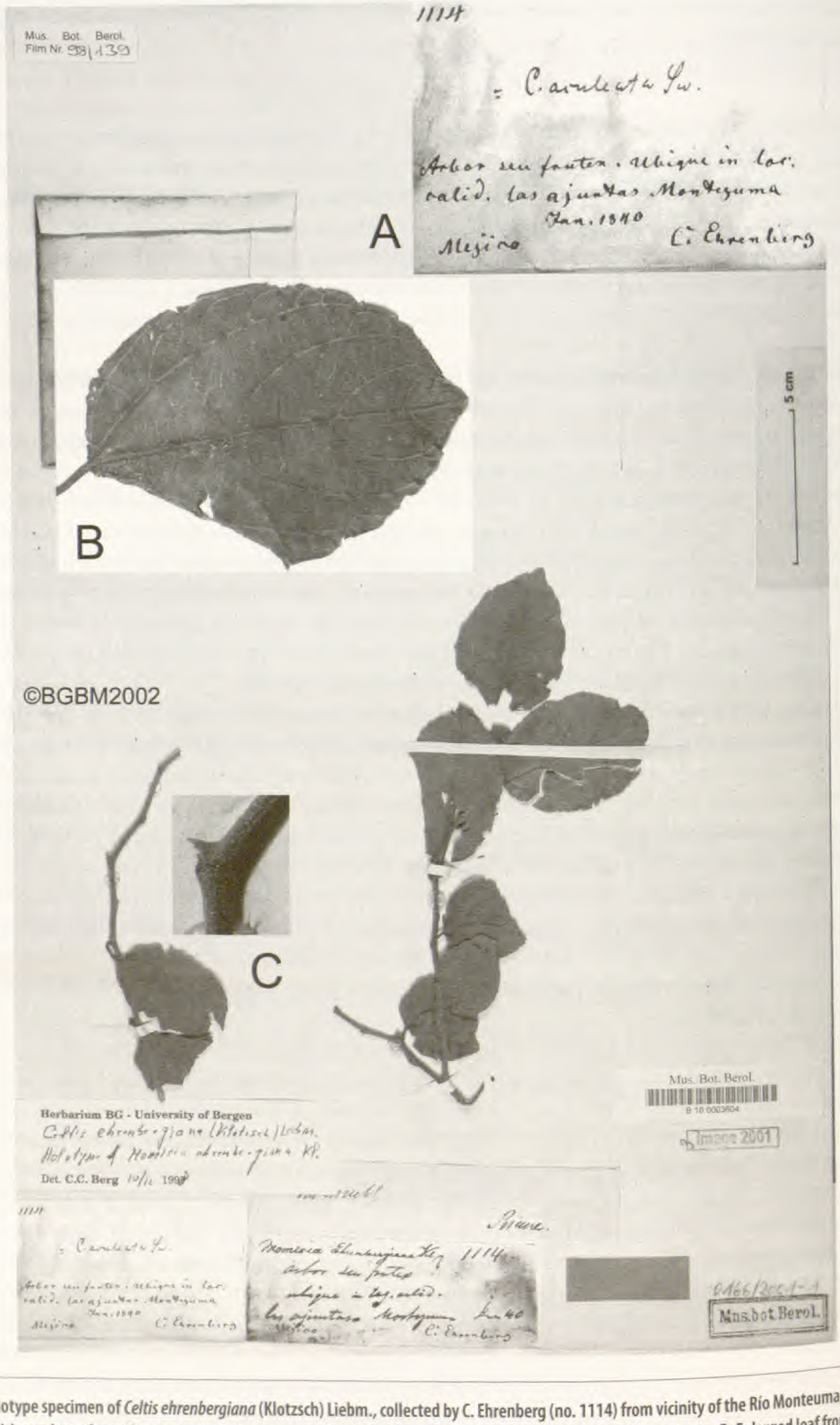
Mus. Bot. Berol.
Film Nr. 98/139
1114
= C. aculeata Sw.
Arbor seu frutex. ubique in loc. calid. las ajuntas Montezuma
Jan. 1840
Mejico
C. Ehrenberg
A
B
5 cm
©BGBM2002
C
Herbarium BG - University of Bergen
Celtis ehrenbergiana (Klotzsch) Liebm.
Holotype of Momisia ehrenbergiana Kl.
Det. C.C. Berg
Mus. Bot. Berol.
B 10 0003604
Image 2001
Mus. bot. Berol.

FIG. 1. Holotype specimen of *Celtis ehrenbergiana* (Klotzsch) Liebm., collected by C. Ehrenberg (no. 1114) from vicinity of the Río Monteuma, Querétaro, Mexico with overlays of specific materials. A. Enlargment of the label from the lower left hand corner of the specimen. B. Enlarged leaf from packet. C. Only one supra axial thorn remains on specimen on fragment to left, it is enlarged in C.

from collections from along the Río Montezuma, in Querétaro joins three other named species described from Mexico that are synonyms of *C. iguanaea* (Jacq.) Sarg. (1895) [based on *Rhamnus iguanaeus* Jacq. (1760)]. These include: *Mertensia laevigata* H.B.K. (1817) [= *C. laevigata* (H.B.K.) Spreng. non *C. laevigata* Willd. (1814)], from the state of Campeche; *C. anfractuosa* Liebm. (1851) from Veracruz; and *C. platycaulis* Greenm. (1903) from Morelos (see Berg & Dahlberg 2001).

CELTIS TALA VS. *CELTIS PALLIDA*

With the removal of *C. ehrenbergiana*, there remains in Berg and Dahlberg's *C. ehrenbergiana* two species that have been previously recognized as distinct: *Celtis tala* Gillies ex Planch. (described in 1848) and *C. pallida* (described in 1858) (Hunziker & Dottori 1976; Berg & Dahlberg 2001). If the two taxa were considered conspecific as treated by Berg and Dahlberg (2001), then *C. tala* would be the oldest available name for the taxon. So I present here a brief analysis of these two species.

Celtis pallida, as noted above, occurs both in North America and in South America in northern Argentina and adjacent Paraguay. *Celtis tala* is confined to north and east Argentina, and adjacent southern Uruguay, and south Brazil (Hunziker & Dottori 1976; Romanczuk & Martínez 1978; Dottori & Hunziker 1994).

Taxonomic history.—Sprengel (1825) in the 16th [17th] edition of Linneaus' *Systema Vegetabilium*, described a *Celtis spinosa* Sprengel from Brazil (location unknown) characterized by flexuous stems and paired curved spines.

Planchon (1848) described *Celtis tala* (spines paired, straight, leaves small, serrate to subentire) from Argentina. Here he also listed Sprengel's *C. spinosa* in his "Species non satis nota" with a notation complaining that the weak diagnosis was not instructive and that the taxon was perhaps better ignored.

In his later treatment in DeCandolle's Prodromus, Planchon (1873) once again ignored Sprengel's *C. spinosa*, but recognized five varieties of *C. tala* that differed in leaf shape and serration, young stem and leaf vestiture, and thorn number and shape. His var. *gilliesiana* of Argentina and Paraguay was considered the type variety (*vel typica*), var. *weddelliana* and var. *gaudichaudiana* were from Brazil, var. *chichape* from Bolivia, and var. *pallida* from Texas and Mexico.

Baehni (1937) resurrected Sprengel's *C. spinosa* and placed the later-described *C. tala* within *C. spinosa* in his treatment of South American *Celtis*. He also recognized Planchon's var. *weddelliana* as a variety of *C. spinosa*. Baehni's treatment was followed by Cabrera (1945), Digilio and Legnane (1966) and Dawson (1967) in their various flora treatments. This also led to M.C. Johnston (1957) making the combination *C. spinosa* var. *pallida* (Torr). M.C. Johnston for North American material.

Romanczuk (May 1976) in her study of Argentian *Celtis*, rejected Baehni's concept of *C. spinosa*, reinstated *C. tala* as a species, but recognized a second species with paired, straight node-bearing spines as *C. weddelliana* (Planch.) Romanczuk. She further recognized a third species, *C. sericea* Romanczuk, differing from her *C. weddelliana* in having broader, crenate leaves, with the lower surfaces velutinous-sericeous (vs. having entire, ovate to narrowly ovate leaves with lower surfaces ± uniformly pubescent). Lectotypes and holotypes were designated for these taxa.

Hunziker and Dottori (June 1976) also rejected the use of *C. spinosa*, showing it was attributable to *C. iguanaea*. They restored the names *C. tala* and *C. pallida* and presented complete synonomy and typified many of the synonyms, and in a post script (after having seen Romanczuk's 1976 paper) took Romanczuk (1976) to task for her typifications. They also listed all collections seen from North and South America. They demonstrated the value of pyrene characters for distinguishing *C. pallida* from *C. tala*, with *C. pallida* having a low reticulate sculpturing, vs. a much higher and variably raised reticulate sculpturing for the pyrenes of *C. tala* and provide pyrene illustrations of both taxa. They also noted that the only difference found between North and South American *C. pallida* taxa involved pyrene size with the North American plants having slightly larger pyrenes (3.3–4.8 × 2.6–3.8 mm) than those in Argentina [(2.4–)2.9–3.8 × (2–)2.4–3.4 mm]. In addition they described a new variety, *C. pallida* var. *discolor* Hunziker & Dottori, that differed from the nominal variety in having bicolored leaves, green and sparsely pilose above and whitish and densely sericeous beneath, and with vein axils having small to very small domatia. In their postscript they retypified

Romanczuk's *C. weddelliana*, noting that it corresponded to their *C. pallida* var. *pallida*, and they equated their *C. pallida* var. *discolor* to Romanczuk's *C. sericea*. Dottori (1976), in a separate paper, contrasted foliar morphology of *C. tala* and *C. pallida*, with special reference to the domatia.

In 1978 Romanczuk and Martinez presented a treatment of *Celtis* of Argentina, recognizing 6 species including *C. tala* and *C. pallida*, the latter with subsp. *pallida* and subsp. *sericea* (here using their epithet at the rank of subspecies rather than Hunziker's var. *discolor*). They presented data on pollen stainability for the six species of Argentina. They also presented phytochemical data obtained from two-dimensional paper chromotography of secondary compounds obtained from dried herbarium specimens using standard butanol-acetic acid-water (6:1:2) vs. 2 % acetic acid runs. Data were given as R.f. values in BAW vs. acetic acid runs, and the color of the spots in U.V. light vs. U.V. light in the presence of ammonia. While the specific compounds corresponding to these spots were not identified, *C. tala* and *C. pallida* gave different patterns of spots, while *C. iguanaea*, *C. spinosa* and *C. pubescens* gave almost identical patterns. The Argentina specimens of *C. pallida* were distinctive, but the signatures of subsp. *sericea* from Argentina were quite similar to those of North American subsp. *pallida*. Romanczuk (1987) also contributed the treatment of *Celtis* to the *Flora Ilustrada de Entre Rios (Argentina)* where she used the name *C. pallida* subsp. *sericea*.

In summary, *C. tala* and *C. pallida* are closely related and share certain characteristics: (1) paired, straight, divergent, supranodal thorns; (2) relatively small, ovate to narrow, entire or distally weakly serrate-dentate leaves with three prominent basal veins and a gap between these and the more distal pinnate secondary veins; (3) domatia mainly occurring along the base of the leaf between the primary-secondary vein axils but also sometimes more distally along the midvein; (4) leaf epidermal cells with striate cuticles (Romanczuk & Martinez 1978); (5) and small glomerate inflorescences consisting mostly of staminate flowers, with few bisexual flowers. There are also consistent differences between the species as indicated in the following key modified from Hunziker and Dottori (1976) and following the nomenclature accepted in the *Catálogo de las Plantas Vasculares de la República Argentina II* (Zuloaga & Morrone 1999) and used in Dottori and Hunziker (1994).

1. Thorns paired, straight, bearing nodes and leaves, (6–)15–35(–46) mm long [but some shorter thorns (1.4–) 2–5(–12) mm long lacking nodes]; pyrenes generally (2.4–)2.9–4.8 mm long, (2–)2.4–3.8 mm wide, superficially reticulate (rarely smooth), the reticulae low, flat surfaced;. ____ **Celtis pallida**
    2. Leaves concolorous, hairs few above, more common below, or the hairs common on both surfaces and then large and erect (none appressed); basal leaf domatia large, inflated; shrubs (1–)1.5–2.5(–3.5) m tall, 5–12 cm in basal diameter; sw. United States and Mexico; n.-cent. Argentina, rare in adjacent Paraguay. ____ **Celtis pallida** var. **pallida**
    2. Leaves generally bicolored, with a dense whitish indument of short appressed hairs on the lower surface, upper leaf surface with few hairs or glabrescent; basal leaf domatia small, sometimes inconspicuous; shrubs to small trees 1.4–5 m tall, 8–15 cm in basal diameter; n. Argentina. ____ **Celtis pallida** var. **discolor**
1. Thorns paired, straight, lacking nodes and leaves, (1.5–)3–15(–20) mm long, (nodes sometimes present on sucker shoots); pyrenes (3.6–)4.8–5.8(–6) mm long, 3–5(–5.6) mm wide, the reticulae surfaces irregularly raised; trees (3–)4–8(–10)[–20] m tall, with trunks 3–6(–10) dm in basal diameter; s. Brazil, s. Uruguay, n-central Argentina. ____ **Celtis tala**

As the above key shows, *Celtis pallida* is a shrub-small tree 1.5–5 m tall with basal trunks 3–15 dm in diameter, the paired nodal thorns bear nodes and leaves, the fruit pyrenes are 2.4–4.8 × 2–3.8 mm in size, and the pyrene surface is marked with a low flat-surfaced reticulation. In contrast *Celtis tala* grows to be a large tree 4–10(–20) m in height with basal trunks 3–6(–10) dm in diameter; the paired nodal thorns do not form nodes and leaves, and the fruit pyrenes are slightly larger, 3.6–6.0 × 3.0–5.6 mm, with the reticulate patterns irregularly raised (see comparative illustrations in Hunziker and Dottori (1976), Romanczuk and Martinez (1978), Burkart (1987). But the problem with these species is the variation found in leaf size, outline, toothing, and the development of thorns. In Texas-Mexico *C. pallida*, leaf and thorn size varies greatly, along with leaf indentation, vestiture (sericeous, hirtellous to glabrous) and in well developed long shoots the paired supranodal thorns are well developed, with conspicuous nodes on the thorns but in other collections or branches of the same specimen thorns are highly reduced, often unequal in size, and without nodes. If one looks only at the vegetative aspects of *C. pallida* vs. *C. tala*, they appear to blend together. But, the pyrene differences are consistent. And the trends in thorn nodes are real.

The above shows that there are differences between *C. tala* and *C. pallida* that have been used by Argentinean botanists to recognize the taxa as separate species and they were so recognized in the latest published catalogue of the vascular plants of Argentina (Zuloaga & Morrone 1999), though in most recent unpublished enumeration of the flora obtained from the Instituto de Botánica Darwinion the above taxa are all placed within *C. ehrenbergiana* following Berg and Dahlberg (2001).

In contrast to the paper of Berg and Dahlberg (2001), I conclude that *C. ehrenbergiana* should be considered a northern-most representative and a synonym of the widespread *C. iguanaea* (Jacq.) Sarg. and not related to the *C. tala-pallida* complex. Furthermore, based on the characteristics expressed by Hunziker and Dottori (1976) noted in the above key, I support the recognition of *C. tala* and *C. pallida* as distinct species. All the North American material should be referred to as *Celtis pallida* Torr. var. *pallida* in deference to the recognition of the South American *C. pallida* var. *discolor* and var. *pallida*. Of course, the one South American taxon can also be recognized as *C. pallida* subsp. *sericea* Romanczuk vs. *C. pallida* subsp. *pallida*. I also feel that the final disposition of *C. tala* vs. *C. pallida* and its varieties should involve a thorough molecular study and/or be made by botanists with extensive field experience in Argentina and not by botanists without first-hand knowledge of the taxa.

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BOOK REVIEW

JANE S. SMITH. 2009. **The Garden of Invention: Luther Burbank and the Business of Breeding Plants.** (ISBN 978-1-59420-209-4, hbk.). Penguin Press, Penguin Group (USA) Inc., 375 Hudson Street, New York, New York 10014, U.S.A. (**Orders:** www.penguin.com). $25.95, 345 pp., 5 1/2" × 8 1/4".

Though it might be difficult to find someone who has never heard of Luther Burbank, there are many people who don't understand the scope and depth of his work. Author Jane Smith does an incredible job of detailing the life and achievements of Mr. Burbank and explains the implications of his work with plant genetics among other things. Laying the foundation for modern agriculture, Mr. Burbank had a fascinating infatuation with the complexities of nature, and this book is a captivating account of his life. *Garden of Invention* is easy to read, flows well, and is captivating for anyone with an interest in botany or agriculture. Extensively researched and well written, Jane Smith has constructed a detailed biography of one of America's early heroes.—*Haden Shibley, Volunteer, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

From the publisher: "**Jane S. Smith** received her Ph.D. in English from Yale University and has taught at Northwestern University on topics ranging from twentieth-century fiction to the history of public health. Her history of the first polio vaccine, *Patenting the Sun: Polio and the Salk Vaccine*, received the Los Angeles Times Book Prize for Science and Technology. She has served as commentator, consultant, and writer for numerous documentary film projects. She lives in Chicago, where she works in a very small room with a very large window."

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CROTON BIGBENDENSIS TURNER (EUPHORBIACEAE) REVISITED

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ABSTRACT

B.L. Turner separated from the widespread *Croton dioicus*, a new species characterized by more luxuriant stem growth with long internodes and narrower leaves occurring on well drained soils in the Big Bend region of trans-Pecos Texas. Turner's new taxon differs only in a few quantitative (not qualitative) characters, and in these characters it blends into *C. dioicus*. Turner's taxon is considered to be minor variant in a wide-ranging and variable species. Turner's original species description does not meet the requirements for being validly published because two holotypes were designated.

RESUMEN

B.L. Turner distinguió una nueva especie, caracterizada por su crecimiento más exuberante, con entrenudos largos y hojas más angostas, creciendo en suelos bien drenados, en la región del Big Bend de trans-Pecos, Texas, separándola de *Croton dioicus*, especie de amplia distribución. El taxón nuevo propuesto por Turner difiere solamente en unos pocos caracteres cuantitativos (no cualitativos) y, en estos caracteres, se intergrada con los de *C. dioicus*. Se considera al taxón de Turner como una variante secundaria de una especie variable de amplia distribución. La descripción original de la especie nueva de Turner no cumple con los requisitos de publicación válida puesto que se designaron dos holotipos.

INTRODUCTION

Croton dioicus Cav. [*C. neomexicanus* Müll.Arg.] (Euphorbiaceae) is a wide ranging, distinctive, dioecious perennial of *Croton* section *Drepadenium* (Raf.) Müll.Arg. (Webster 1993). The species is characterized by twice dichotomous styles, valvate, eglandular sepals, petals absent, moderately short petioles, and leaves with a distinctive silvery canescence formed by fringed peltate scales 0.3–0.5 mm in diameter. The species occurs from west-central and trans-Pecos Texas and adjacent New Mexico, southward into arid regions of Mexico in the states of Chihuahua, Coahuila, Nuevo León, Tamaulipas, Veracruz, Durango, Zacatecas, San Luis Potosi, Hidalgo, Tlaxcala, México, Puebla, and Oaxaca.

Turner (2004) distinguished from *C. dioicus*, a separate species, with the epithet "bigbendensis," characterized as being a larger, bushier plant, with longer upper-stem internodes and linear-lanceolate leaves 5–7 times as long as wide. He noted that the species is restricted to areas along the Rio Grande in Hudspeth, Presidio and Brewster counties of Texas (with one specimen cited from adjacent Coahuila, Mexico) becoming dominant in sandy habitats. He further noted that the species does not occur with *C. dioicus*, and where they are "near contact" they do not appear to intergrade. He considered his new species to be a good "cryptic" or "biological" species. All the characteristics used to delineate the proposed species were quantitative; no qualitative characteristics were noted or implied.

Unfortunately, in his paper he cites two herbarium specimens as holotypes, one pistillate (*Turner 22-204A*) and one staminate (*Turner 22-204B*), each given a separate number. Though collected at the same time from the same population (a single gathering), the International Code of Botanical Nomenclature (McNeill et al. 2006) does not allow two separate specimens with two separate numbers to be designated as separate holotypes [ICBN Art. 9.1–"A holotype of a name or a species or infraspecific taxon is the **one** specimen or illustration used by the author, or designated by the author as the nomenclatural type (emphasis mine)] and thus the name was not validly published and is considered an invalid name (Kanchi Gandhi, pers. comm.; see International Plant Name Index). A holotype can consist of more than one sheet of a single specimen (ICBN Art. 8.3) if clearly noted, and can consist of more than one plant in a single gathering (Art 8.2), but

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the designation of two separately numbered specimens, mounted on separate sheets, each named as holotype (Turner 2004, pp. 81 & 82), renders the specimens syntypes (Art. 9.4, ex. 1) and therefore no holotype exists and the name is not validly published.

As his proposed new taxon occurs within the Chihuahuan Desert, my area of interest, I analyzed characteristics used by Turner (2004) to distinguish the two taxa using specimens he annotated in the TEX-LL herbarium. I initially measured total stem length and maximum internode length as an indication of plant size, leaf blade length and width as well as petiole length from one larger leaf on each specimen. I also recorded soil type (clay, gypsum, or sandy-well drained) for each collection when noted on the label. Petiole length and total stem length, while quite variable, were not further used because the petiole length generally correlated with leaf size and the total stem length displayed in specimens too often reflects the portion collected, not total plant size. Data on soil type were very spotty from specimens outside west Texas so this was not used in the analyses but is discussed below. While criticism can be raised from taking measurements from herbarium specimens, these are the specimens used to make taxonomic decisions and, while imperfect, they represent samples of a species and they are readily available.

METHODS

Data were collected from all specimens at TEX-LL (*n*=296) with 41 from trans-Pecos Texas identified by Turner as "Croton bigbendensis" plus six of my specimens that are clearly referable to that taxon, 72 from typical *Croton dioicus* in trans-Pecos Texas (west of the River), 98 from *C. dioicus* from cis-Pecos Texas (east of the Pecos River) and adjacent New Mexico, and 85 from *C. dioicus* from Mexico. For the quantitative analysis measurements of longest internode (in mm) present on each specimen, as well as the longest leaf length and its width (in mm) and these were used to formulate a leaf length/width ratio.

RESULTS

Measurements of maximum internode length in mm (abscissa) graphed against a ratio of leaf length/leaf width indicating leaf shape (ordinate) are shown in Figure 1. Collections of putative "*Croton bigbendensis*" are distinguished by open circles; those of *Croton dioicus* are indicated by solid shapes with those from trans-Pecos Texas indicated by solid circles, from cis-Pecos Texas by solid squares, and those from Mexico by solid triangles.

The means and standard deviations of four characteristics recorded from the "bigbendensis" specimens, from the specimens from each of the three areas of *C. dioicus* and from all combined *C. dioicus* are presented in Table 1. While the means of leaf and internode lengths are distinctive, the large standard deviations indicate the wide variation found in *Croton* "bigbendensis."

The graph (Fig. 1) shows that while many specimens of "*bigbendensis*" are characterized by long internodes and/or narrow leaves, the measurements blend into those of *C. dioicus*—there are not two distinct clusters of data points indicating well defined character differentation, and a fourth (10 of 41) of the "bigbendensis" data points are nested within those of *C. dioicus*. The specimens of the proposed taxon "bigbendensis" have leaf l/w ratios averaging 5.9, ranging from 3–14.4, and maximum internode lengths averaging 50.0 mm ranging from 31–98 mm. Specimens assignable to *C. dioicus*, in contrast, have leaf l/w ratios averaging 3.5, ranging from 1.4–6.8, and maximum internode lengths averaging 30.4 mm, ranging from 11–72 mm. Both features exhibit strong quantitative overlap.

Throughout the geographical range of *Croton dioicus* there is much variation in plant habit, leaf shape and leaf and internode size (Fig. 1). In growth form plants range from low, woody-based subshrubs with erect new growth, to plants that die back to the base and produce erect-ascending shoots that eventually fall and give rise to upright lateral shoots during the growth season. In most plants the basal leaves are largest and the terminal, younger leaves are progressively smaller and often narrower. Leaf shape ranges through broadly ovate, elliptical, oblong-ovate, oblong-elliptic, oblong-lanceolate, linear-lanceolate, and linear. Plants from central Texas and northeastern Mexico have broader, more ovate, moderate- to large-sized leaves

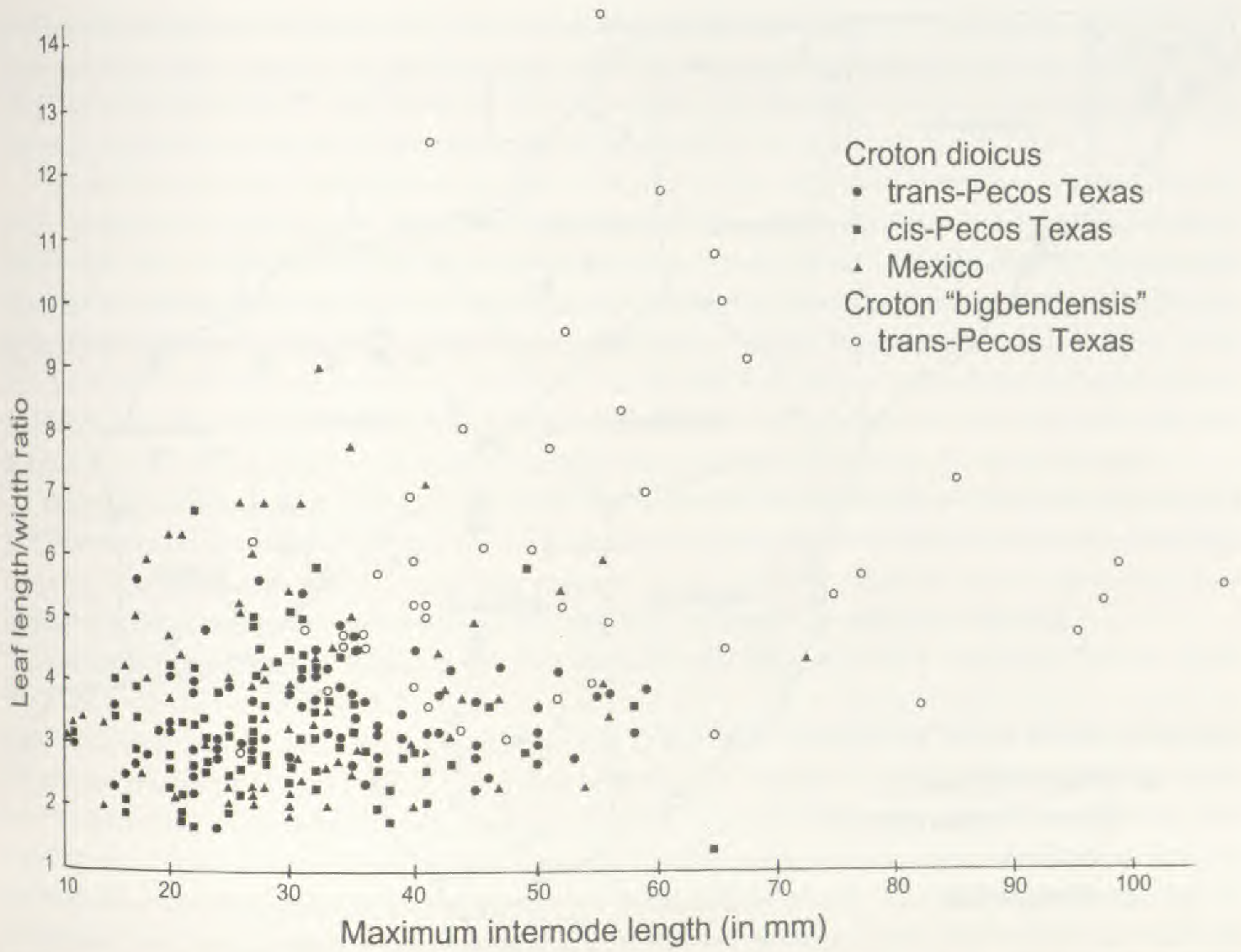

Fig. 1. Graph showing relation of leaf blade length/width ratio vs. maximum internode length (in mm). Measurments taken from 294 specimens at TEX-LL herbarium. Not all overlapping data points are shown.

Table 1. Means and standard deviations of measurements taken of the longest leaf (length, width, and lenght/width ratio) and the longest internode of each specimen annotated as "bigbendensis" by Turner, and each specimen of *Croton dioicus* from trans-Pecos Texas, cis-Pecos Texas, and Mexico. All *C. dioicus* specimens are combined.for the mean and standard deviation of "dioicus-all collections".

Taxon	**count**	**Lf length-mm**	**Lf width-mm**	**Lf. L/W ratio**	**Internode length**
"bigbendensis"	41	35.3 ± 10.0	6.3 ± 2.0	5.9 ± 2.4	50.0 ± 19.5
dioicus-trans-Pecos	72	25.4 ± 6.7	7.7 ± 2.1	3.4 ± 0.8	32.0 ± 11.2
dioicus-cis-Pecos	98	23.4 ± 5.2	7.7 ± 2.2	3.2 ± 0.9	29.3 ± 10.2
dioicus-Mexico	85	24.9 ± 7.3	7.1 ± 2.4	3.8 ± 1.5	30.4 ± 11.4
dioicus-all collections	255	24.5 ± 6.4	7.5 ± 2.2	3.5 ± 1.2	30.4 ± 10.9

Those of desert habitats often have more numerous, smaller leaves, but in years of good rainfall they may develop large leaves and strong terminal growth. Overall, the leaves of *C. dioicus* in trans-Pecos Texas are oblong-elliptical to elliptical ovate but are otherwise very similar to those of "bigbendensis."

Figure 2 shows the distribution of plants of *Croton dioicus* and "bigbendensis" in trans-Pecos Texas based on specimens annotated by Turner (2004). *Croton dioicus* is indicated by solid circles and well differentiated "bigbendensis" (i.e. those with narrower leaves and/or long internodes) are shown as open circles, and the location of those specimens annotated as "bigbendensis" by Turner, but nested with *C. dioicus* in Figure 1, are designated by open squares. This map differs from that of Turner (2004) as it shows the two taxa growing

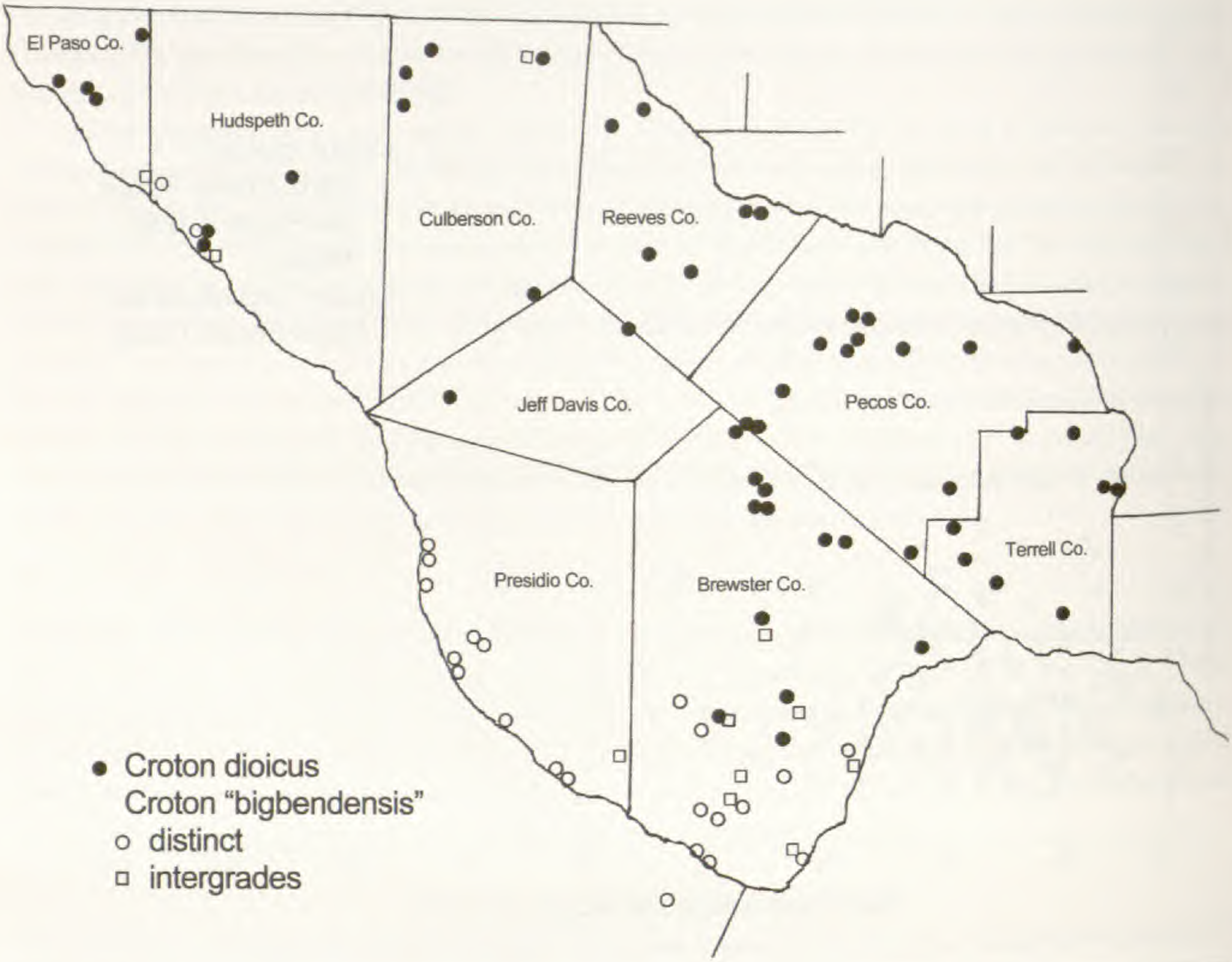

Fig. 2. Distribution of *Croton dioicus* and "bigbendensis" in trans-Pecos Texas, based on specimens so identified by Turner at TEX-LL.

in close proximity in southeast Hudspeth and central Brewster counties. There are collections within the range of "bigbendensis", annotated by Turner as *C. dioicus* that were not shown in his map: (1) Brewster Co., Chisos Mts. to Coopers Store (= Persimmon Gap), *Lundell & Lundell 13294* (LL), with internodes to 40 mm long, leaves to 32 × 10.5 mm (l/w ratio 3.0); (2) Persimmon Gap, *Warnock 5/2/37* (TEX), with internodes to 35 mm, leaves 27 × 5.7 mm (l/w ratio 4.7); (3) 21 mi s of Marathon, *Ertter 4707* (TEX), with internodes to 46 mm; leaves 27 × 6 mm (l/w ratio 4.5) and Nine Point Mesa, Webster and Westlund 32586 (TEX) with internodes to 52 and leaves 26 × 9.2 mm (l/w ratio 2.8). These have shorter internodes and/or broader leaves than typical "bigbendensis" and are shown in figure 2 as *C. dioicus*.

There are also collections of *C. dioicus* well outside of the range of Turner's "bigbendensis" that are also similar to his proposed new species: (1) Culberson Co. Guadalupe Mt. area, *Correll & Johnston 24260* (LL), with internodes to 56 mm, leaves 36 × 9.5 mm (l/w ratio 3.8) to 20 × 3.4 mm (l/w ratio 5.8); 41 mi N Van Horn, in gypsum, *Correll & Johnston 18360* (LL) with internodes to 31 mm, leaves 33 × 6 mm (l/w ratio 5.5); (2) southeast Hudspeth Co., Finlay to McNary, in sand, *B.H. Warnock 13668* (TEX), with internodes to 55 mm, leaves 51 × 13 mm (l/w ratio 3.8). These are basically robust plants of sandy-gravelly habitats with large but broader leaves.

In Mexico, a collection from the Samalayuca dunes south of Cd. Juaréz, Chihuahua (*M. F. Roberts s.n.*, TEX) with internodes to 80 mm; leaves 27 × 7 mm (l/w ratio 3.8) seems to compare well with "bigbendensis" except that the leaves are overall shorter. Specimens from the state of Hidalgo all had linear to narrowly oblong leaves with l/w ratios from 3.9–7.9, and longest internodes from 18 to 52 mm. Likewise specimens from Puebla also had narrow leaves with l/w ratios of 3.9–6.3, but internodes 27–55 mm in maximum length. Some specimens from Nuevo León, also compare well with the proposed "bigbendensis," e.g., *Urbatsch 1019* (TEX), with internodes to 41 mm, leaves 37 × 5.2, (l/w ratio 7.1), showing that the characteristics used by Turner to establish his new taxon were by no means restricted to the Big Bend area of Texas.

The one characteristic that was not possible to analyze is that of growth habit. Most *Croton dioicus* in Texas is suffrutescent-suffruticose, woody at the base, with herbaceous stems above forming bushes to about 2-3 dm tall, with the size reflecting water resources of the season. Plants of "bigbendensis" are typically larger. Turner (2004) notes the hight of "bigbendensis" as 4–5 dm. However, *Lott et al. 5588* [Presidio Co., Texas (TEX)] notes growth habit as a single-stemmed shrub to 1 m tall, *Turner 24-351* [Hudspeth Co. Texas (TEX)] includes a photograph of a bushy plant ca. 1 m tall and wide. I have seen plants in the foothills of the Chianti Mts. (Presidio Co., Texas) with long lax stems that are initially erect but that eventually fall over and produce erect sucker shoots to form low rounded plants about 3 dm tall but 12 dm in diameter.

Regarding substrate, most of the specimens of "bigbendensis" are from sandy or otherwise well drained soils, but others are from clay-limestone flats and hillsides and still others are from roadsides etc. Label data is missing on some specimens or is otherwise vague as to the soil type. There are several collections from Brewster Co.,Texas that were noted coming from clay flats, or limestone substrates-hillsides.

Two collections made by Turner in 2004 in gypsum soils in northeastern Culberson County, Texas (Fig 2) illustrate the problem with Turner's interpretation of the taxon. *Turner 24-409* (TEX) is a pistillate plant considered to be *C. dioicus* that has oblong-ovate leaves with rounded tips, 26.5 × 8.2 mm (l/w ratio 3.2) and internodes to 42 mm long. It is growing with/near a staminate specimen (*Turner 24-402*) (TEX) that has lanceolate, acute-tipped leaves, 31 x 6.5 mm (l/w ratio 4.7) with internodes to 46 mm long that is identified as "bigbendensis." The two specimens appear identical in stature, coloration etc. and both are in flower. But while the specimen he considers to be "bigbendensis" is well out of its normal range (Fig. 2), the specimen of *C. dioicus* bears a hand-written note by Turner "growing with *C. bigbendensis* (24-402); no intermediates seen." I see this as just variation within a population of *C. dioicus*.

Turner's *Species Concepts*: Turner (in Turner 2001; Turner et al. 2003; Turner 2004) advocates the biological species concept implying that his species have some degree of biological (i.e., reproductive) isolation sensu Mayr 1969, 1992. At the same time, in his personal discussions, he speaks of the importance eco-geo-morphological factors (or morpho-eco-geographic integerity, Turner 2001) in species recognition in which species may differ ecologically i.e., occur in different habitats, or in different soil types (gypsum, sand) or be geographically isolated (disjunct) and/or have some morphological discontinuity or a combination of these features. His primary rank for infraspecific taxa is variety, with subspecies reserved only for clustering groups of varieties if the need arises sensu Holmgren (1994) and Turner and Nesom (2000). He notes that varieties are subunits of a species that are geographically separate and generally morphologically distinguishable, but in Turner's concept they **must** show intergradation with related taxa to be varieties: if he sees no intergradation, they are considered distinct species (Henrickson 2004).

The concept that varieties must show intergradation is where Turner departs from others. He considers his interpretation as modern in contrast to Old-School definitions where varieties are used for minor varients of a species as defined in Correll and Johnston (1970) and Diggs et al. (1999). But I think it is safe to say that most botanists today recognize varieties (or subspecies) as subunits of a species that have a geographical component (Stuessy 2009) but without such regard to the presence or absence of intergradation. And then there is the separate question of whether all variation found in wide-ranging species needs to be recognized nomenclaturally. But Turner's varietal concept does explain why he publishes so many new species.

It is expected that all outbreeding species will exhibit some degree of variation, and that in peripheral populations, selection would favor those individuals best adapted to any new biotic or abiotic environmental parameters. Over time, all populations tend to move toward adaptation to their current environment. In small populations, these changes can be enhanced, sometimes in a non-adaptive way, by genetic drift (Grant 1963). If the location of an outlying population differs in substrate or in moisture availability, you would expect changes reflecting adaptation to this new environment. But even if adaptive characteristics become fixed in an outlying population, does this make the population a distinct species?

In this particular instance, *Croton dioicus* of northern trans-Pecos and adjacent portions of central Texas mostly occurs in clay flats in which much of the rainfall runs off quickly, and the plants tend to be short, low rounded specimens adapted to a seasonally severe environment. In areas of sandy-gravelly substrates, the water can penetrate deeply, providing a reservoir of water for later development. Rhyolitic substrates can form coarse gravels-sands that also accumulate rainwaters. Other sandy habitats in this region occur along the Rio Grande. An increase in moisture availability would favor those plants that could grow larger and produced more flowers and fruits over a season. This would not require any novel gene-based changes, but rather would simply favor those plants within a population that produce more growth-regulating substances (auxins etc.) that would in turn promote more robust plants with longer internodes and stems and leaves, characteristics that would not be adaptive in drier sites. Since the southern portion of the southwestern trans-Pecos Texas has volcanic (not limestone) mountains, and has other sandy habitats along the Rio Grande, the sandy-gravelly habitats tend to be geographically separated.

With Turner's eco-geo-morphological concept, he finds ecological, geographic and morphological differences between the clay- vs. sandy-substrate populations. But he notes that his new species is a biological species sensu Mayr (1969, 1992), though providing no evidence that the two taxa have any reproductive isolation. His map (Turner 2004) shows the two taxa as completely allopatric, but using his own specimens as mapped here in figure 2 (some added after his publication), they are not completely allopatric except in the sands along the Rio Grande in Presidio Co., Texas.

What we are dealing with in "bigbendensis," appears to be a derivative series of populations in well drained soils that differ only in quantitative characteristics from those on primarily clay substrates. In characteristics of vestiture, flower, and fruit, and time of anthesis, they are identical to the widespread *C. dioicus*. Quantitative characters can be used to establish species if there are no or reduced overlapping values (Luckow 1995). But as shown in Fig. 1, the values of C. "bigbendensis" merge strongly with those of *C. dioicus* making recognition at the species rank, in my opinion, untenable. As noted above, measurements of 10 of the 41 specimens recognized by Turner as "bigbendensis" are nested well within the specimens of *C. dioicus* (Fig. 2) and others are closely peripheral. Even if these were to be considered *C. dioicus* and "bigbendensis" were redefined as only those plants with longer internodes and/or narrower leaves, "bigbendensis" would still consist of an amalgamation of plants, some with narrower leaves and others with longer internodes, that would not separate from the variation in *C. dioicus*.

There is another problem associated with such quantitatively defined "taxa." In times of good rains, the plants can show strong growth with long leaves and internodes. But under poor growth conditions, the plants may be stunted with shorter internodes and smaller leaves and some of the plants nested within *C. dioicus* in figure 2 may be just that. Also, the first-formed leaves of a growth season are typically broader than those formed later in the season.

But while the data do show the existence of plants with narrower leaves and longer internodes in the southern margin of trans-Pecos Texas, the plants are not clearly distinguished from *C. dioicus*. Due to the blending of the quantitative characteristics used to define "bigbendensis," using Turner's own criteria (Turner and Nesom 2000), the taxon would be considered a variety of *C. dioicus*. But, I see no reason to recognize "bigbendensis" at any rank, but to incorporate it's characters into the known variation of the wide ranging and poorly studied *Croton dioicus*. As it stands, *Croton dioicus* is a very distinctive species, easily recognized over its range by substantial characters. I see no value in recognize peripherial populations that differ in minor quantitative characters as equal species. Certainly in this instance there is no evidence that "bigbendensis" is a good biological species. But we must remember that even with field observations, without experimental data, such taxonomic decisions are just opinion.

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BOOK NOTICE

Robert D. Dorn. 2010 (March). **The genus *Salix* in North America North of Mexico.** Published by the author. (**Orders:** digital version available for free at www.lulu.com/content/8538913; printed copy available in US only from Mountain West Environmental Services, 8481 Road 39, Lingle, Wyoming 82223, U.S.A.; e-mail: linglebird@yahoo.com). $7.00 (for printed copy), 59 pp., 8 1/2" × 11".

A 35-page supplement of color photos is available for free download at www.lulu.com/ content/8540320. A printed copy of the photo supplement is not available. Text includes pistillate and staminate keys, descriptions, and distribution maps for 112 native taxa and 9 naturalized taxa (no maps for latter); classification summary, index to names; and one new combination (Subsection Wolfianae).

THOMAS WALTER'S SPECIES OF *MELANTHIUM* (LILIACEAE)

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ABSTRACT

Thomas Walter, in his *Flora Caroliniana* (1788), included seven names within the genus *Melanthium* (Liliaceae). His names are here associated with the modern species they represent, within the genera *Amianthium*, *Chamaelirium*, *Helonias*, *Melanthium*, *Tofieldia*, and *Zigadenus*. *Melanthium hybridum* is restored as the prior name for the plant recently known as *Melanthium latifolium* or *Veratrum latifolium*.

Key Words: Thomas Walter, *Flora Caroliniana*, Liliaceae, Melanthiaceae, *Melanthium*

RESUMEN

Thomas Walter, en *Flora Caroliniana* (1788), incluyó siete nombres dentro del género *Melanthium* (Liliaceae). Sus nombres aquí están asociados con las especies modernas que representan, dentro de los géneros *Amianthium*, *Chamaelirium*, *Helonias*, *Melanthium*, *Tofieldia*, y *Zigadenus*. *Melanthium hybridum* es restituido como nombre prioritario de la planta recientemente conocida como *Melanthium latifolium* o *Veratrum latifolium*.

In the 1780s, Thomas Walter owned and operated a rice plantation on the Santee River, now in Berkeley County, South Carolina. With a classic education and a keen and inquisitive mind, and guided by his few books by Carl Linnaeus, Walter observed the plants he found around him and prepared an inventory. His *Flora Caroliniana*, published in 1788, was the first American flora to follow Linnaeus's sexual system of classification and binomial nomenclature.

Walter kept no herbarium (Ward 2007b), and his brief descriptions, in Latin, have been in many cases difficult or impossible for later workers to associate with the plant species he intended. Because of the early date of his book, many of Walter's names are prior to names given the same plants by Michaux, Pursh, Nuttall, and other early authors. In many cases Walter's names are recognized as prior and are in modern use. Others lurk in obscurity, potentially of nomenclatural importance, but overlooked or neglected because of the uncertainty of their identification. Though no complete analysis of Walter's 400+ new names has yet been published, authors have from time to time dipped into Walter's *Flora* with the objective of matching his names with known species. Notably, Hitchcock (1905) has addressed the grasses, Blake (1915) various species, Dayton (1952) the pines, and Wilbur (2002) the oaks.

The present task is to examine and identify the seven names that Walter used for species within the genus *Melanthium*. These species are now seen as representing six distinct genera: *Amianthium* Gray, *Chamaelirium* Willdenow, *Helonias* Linnaeus, *Melanthium* Linnaeus, *Tofieldia* Hudson, and *Zigadenus* Michaux. Historically, these six genera have been included within the Liliaceae. Five of these genera, with others, are often now recognized to represent a distinct family, the Melanthiaceae. *Tofieldia* has been segregated into a separate family, the Tofieldiaceae. As such, most of the included species have been given careful study, with their morphology and relationships now well understood (Zomlefer 1997a, 1997b; Zomlefer et al. 2001, 2006).

One name formed by Walter, however, has at times been misinterpreted or improperly dismissed. As early as Elliott (1817), Walter's *Melanthium hybridum* was understood to be the "broad-petaled" *Melanthium* (or *Veratrum*) of the Southern Appalachians. Fernald and Schubert (1948: 193) confirmed application of the name. Zimmerman (1958: 281) also accepted the name (as a *Veratrum*), though simply as "ex char." The name was used by H.E. Ahles in the regional Carolina flora (Radford et al. 1968). However Bodkin (1979) stated *M. hybridum* to be "misapplied" and "not in accordance with the rules of nomenclature." Zomlefer (1997a: 160–165) followed Bodkin's lead in rejecting Walter's name (though placing the name within *Veratrum*).

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Bodkin and Utech (2003: 78), under *M. latifolium* Desrousseaux (1797), again dismissed Walter's name as "misapplied" without stating where the name should be correctly assigned.

But if one believes that *Melanthium hybridum* was not a figment of Walter's imagination, his name cannot be ignored. With the assumption that Fernald and Schubert (1948) and Zimmerman (1958) could not have been far afield in their identification, Walter's plant must have been one of the few species of Melanthiaceae to occur in the Southern Appalachians and adjacent coastal plain. His description excluded other related genera, and the orbicular, crinkled tepals of *M. hybridum* (imperfectly described by Walter as "*plicato-undulatis*") contrast sharply with the elliptic, plane tepals of *M. virginicum* (which Walter knew as *M. monoicum*). As to Walter's name not being in accord with "the rules of nomenclature," the statement is made without substantiation. Walter's *M. hybridum* (1788) is prior to Desrousseaux's *M. latifolium* (1797). There appears to be no impediment to recognition of *Melanthium hybridum* Walter as the correct name for the broad-petaled *Melanthium* of the Southern Appalachians.

Walter's Santee River home was on the South Carolina coastal plain. His plants, as noted in the introduction to his *Flora*, came from within a 50-mile radius. The Scottish horticulturist, John Fraser, with his travels to the higher Appalachians and into central Georgia (Ward 2006, 2007b), had access to a wider array of species. It has long been acknowledged that some of Walter's plants reached him via Fraser (though perhaps fewer than sometimes stated). The Fraser fir (*Abies fraseri*), Fraser magnolia (*Magnolia fraseri*), and showy lady-slipper (*Cypripedium reginae*), all montane or upper piedmont species, are outstanding examples.

The identifications given here are subject to an unavoidable level of uncertainty. The basis for each identification is initially Walter's Latin diagnosis, which too often is brief and ambiguous. Additional guidance can at times be obtained from early authors with knowledge of the Carolina flora. Three decades after Walter's death, Elliott, with his *Sketch of the Botany of South Carolina and Georgia* (1816–1824), often was perceptive of his predecessor's intentions. Britton clearly tried to account for all the Walter names that occurred within the range of his *Illustrated Flora* (Britton and Brown 1896–1898). *Index Kewensis*, compiled by Jackson (1893–1895), listed essentially every Walter name, though too frequently reflecting Jackson's unfamiliarity with American plants.

Perhaps the most powerful aid to correct identifications of Walter's names is modern knowledge of present plant distribution within the Carolinas. The maps prepared by Radford and colleagues (Radford et al. 1968) permit tabulation of species likely to have been known to Walter on the Carolina coastal plain. Even so, many species may have become much less frequent in subsequent years, possibly through climate change and certainly through habitat modification. Thus species that would seem attainable only by way of Fraser may possibly have once grown in Berkeley County or environs.

Notations in Walter's book at times carry unpublished information. His *Flora*—as an original publication—is rare. A more widely available facsimile edition was published in 1946. This facsimile preserved the sequence of the original copy's owners, as ascribed on the title page, from James Macbride in 1812 to Charles Sprague Sargent around 1900. One of the owners (the handwriting has not been identified) added marginal notes to certain pages, such as pages 125 and 126 regarding *Melanthium*. These notations, at minimum, record the thoughts and speculations of an attentive early botanist.

Of Walter's seven species of *Melanthium*, only three (Radford et al. 1968) occur with any frequency on the Carolina coastal plain—his *M. virginicum* (= *Zigadenus glaberrimus*), *M. Muscaetoxicum* (= *Amianthium muscaetoxicum*), and *M. racemosum* (= *Tofieldia racemosa*). His other four—*M. hybridum* (= *Veratrum hybridum*), *M. monoicum* (= *Veratrum virginicum*), *M. spicatum* (= *Helonias bullata*), and *M. dioicum* (= *Chamaelirium luteum*)—are rare or absent within his range, and best explained as having come by way of Fraser. Walter's lack of opportunity to know these species in the field may have contributed to his unclear and sometimes conflicting descriptions. (Another species, *Stenanthium densum*, is also frequent on the coastal plain, yet unmentioned by Walter. See discussion under *Amianthium muscaetoxicum*.)

The species are recorded below in the sequence given by Walter (1788). Each entry consists of the scientific name and Latin diagnosis (in *italic*) provided by Walter; the modern name, conforming to the judgment of the present writer; and pertinent comments of the present writer. Walter's division of *Melanthium* into two sections is recorded, with his diagnostic details (in *italic*). Marginal notations of a previous owner of the original volume are also transcribed (in *italic*). Specimens noted to be in the Fraser/Walter herbarium are now held by the Natural History Museum, London (BM); they were collected in 1787 by John Fraser and seen at least in part by Thomas Walter (Ward 2006, 2007b).

LIST OF SPECIES

SECTIONAL CHARACTERS: *Petalis unguiculatis imprimis albis demum obscuro-rubris feminibus* semi ovatis.

WALTER'S NAME: *Melanthium virginicum* (p. 125) Linnaeus, Sp. Pl. 339. 1753; misapplied.
WALTER'S DESCRIPTION: *petalis planis maculis duabus flavis notatis, floribus plerumque hermaphroditis.*
MARGINAL NOTATION: "*hic Zigadenus glaberrimus Michx.*"
MODERN NAME: **Zigadenus glaberrimus** Michx.
COMMENTS: A first assumption was that Walter's *Melanthium virginicum* is simply the *Melanthium virginicum* of Linnaeus (1753). However, Walter's description better fits *Zigadenus glaberrimus*, a frequent species in eastern South Carolina. The perfect flowers and two distinct yellow glands on each tepal ("*maculis duabus flavis*") are diagnostic. Specimen 71-A of the Fraser/Walter herbarium (BM) is probably this; it was labeled "*Melanthium virginicum*" by Walter. True *Melanthium virginicum*, a rare species, was also known to Walter, but under another name (*M. monoicum*, q.v.). Misidentifications by Walter of Linnaean names are not uncommon (Wilbur 2002; Ward 2007b).

WALTER'S NAME: *Melanthium hybridum* Walter (p. 125)
WALTER'S DESCRIPTION: *petalis plicato-undulatis [i]mmaculatis, floribus masculis et foemineis mixtis.*
MODERN NAME: **Melanthium hybridum** Walt. [= *Melanthium latifolium* Desr. in Lam.; *Veratrum latifolium* (Desr. in Lam.) Zomlefer]
COMMENTS: Rare in South Carolina, frequent in western North Carolina; likely a Fraser discovery. No specimen that can be considered Walter's type is known. [Desrousseaux (1797) cited a Fraser collection, possibly seen by Walter, in the Lamarck herbarium, Paris (photo, GH), but made it the type of his *Melanthium latifolium*.] A neotype for *M. hybridum* has been selected elsewhere (Ward 2008b). The justification for restoration of Walter's name is provided above.

WALTER'S NAME: *Melanthium monoicum* Walter (p. 125)
WALTER'S DESCRIPTION: *petalis planis, maculis 2 luteis, floribus inferioribus masculis majoribus, paniculis lateralibus; superioribus foemineis racemo terminali.*
MARGINAL NOTATION: "*Melanthium virginicum Michx. ? /* [*Zygadenus* (deleted)] *Mx*"
MODERN NAME: **Melanthium virginicum** L. [= *Veratrum virginicum* (L.) Ait.]
COMMENTS: Rare in South Carolina (two counties), frequent in North Carolina; likely a Fraser discovery. Walter's unusually lengthy diagnosis is adequate for *Melanthium virginicum*; its flowers are often imperfect. No type is known, and no specimen has been identified in the Fraser/Walter herbarium (BM). Because Walter's name will remain in synonymy, no neotype is needed.

SECTIONAL CHARACTERS: *Petalis sessilibus, feminibus* ovatis.

WALTER'S NAME: *Melanthium Muscaetoxicum* Walter (p. 125)
WALTER'S DESCRIPTION: *scapo thyrsifero, floribus hermaphroditis, petalis imprimis albis demum viridibus.*
MARGINAL NOTATION: "*Helonias* [word deleted] */ erythrosperma Michx.*"
MODERN NAME: **Amianthium muscaetoxicum** (Walt.) Gray [= *Zigadenus muscaetoxicum* (Walt.) Regel]
COMMENTS: Frequent throughout. Walter's name has been uniformly considered to apply to the plant presently carrying his epithet. The change in tepal coloration with age, from white to greenish, is quite characteristic. No type specimen is known. A neotype has been selected elsewhere (Ward 2008a), thereby confirming Walter's epithet in this usage. However, a marginal note (immediately following, by a previous owner of

the volume from which the 1946 facsimile was copied) well indicates the uncertainty that Walter's descriptions left behind. Another species, frequent on the coastal plain and surely known to Walter, appears not mentioned by him. This is *Stenanthium densum* (Desr.) Zomlefer & Judd [= *Zigadenus densus* (Desr.) Fern.; *Amianthium angustifolium* (Michx.) Gray; *Tracyanthus angustifolius* (Michx.) Small], a plant quite similar to *A. muscaetoxicum* but separated (often to generic rank) by its small single tepal glands (vs. tepal glands absent in *A. muscaetoxicum*). As the previous owner suggested (below), Walter may have confounded the two species.

Marginal notation (at page bottom, below all text): *"Which of these is the Helonias angustifolia Michx. / It is confounded with M. muscaetoxicum or omitted."*

Walter's name: *Melanthium spicatum* Walter (p. 125)
Walter's description: *spica nutante, flor. hermaph. radice fibrosa, fol. caulinis subovatis.*
Modern name: Probably **Helonias bullata** L.
Comments: If correctly identified, this species is very rare in western North Carolina, South Carolina, and northern Georgia; it is likely a Fraser discovery. Specimen 58-C (BM) appears to be *Helonias bullata*; it shows a distinctive short-spicate inflorescence, although the leaves are atypically narrow. The specimen was numbered "579" by Fraser, and labeled *"Helonias bullata ?"* by Walter. Since Walter must have relied on Fraser material for his description, it is unclear why he would have used Linnaeus's name on the label and formed a new name in his text. Thus there must be doubt as to identity of Walter's plant. *Melanthium spicatum* was suggested by Index Kewensis (Jackson 1893–1895) to be *Xerophyllum setifolium* Michx. [now *X. asphodeloides* (L.) Nutt.]. But Walter stated cauline leaves to be *"subovatis,"* while *X. asphodeloides* leaves are linear, almost acicular. If specimen 58-C should be confirmed as *Helonias bullata*, the probability that Walter relied on this or other material of the same Fraser collection would justify designation of 58-C as lectotype of *Melanthium spicatum* Walt. [Rationale for such typification is given by Ward (2007a).] However, the status of that epithet as a synonym of Linnaeus's prior name makes this designation unnecessary.

Walter's name: *Melanthium dioicum* Walter (p. 126)
Walter's description: *petalis sublinearibus.*
Marginal notation: *"Veratrum luteum Linn. / Helonias pumila, Jacquin."*
Modern name: **Chamaelirium luteum** (L.) Gray [= *Veratrum luteum* L.]
Comments: Rare on South Carolina coastal plain, common inland. Walter's diagnosis is exceedingly brief (two words), but the narrowly oblanceolate tepals of *Chamaelirium luteum* correspond well, and usage by other authors has been consistent. No type specimen is known. Linnaeus's prior epithet makes designation of a neotype unnecessary.

Walter's name: *Melanthium racemosum ?* Walter (p. 126)
Walter's description: *racemo termiali, pedunculis trifloris, floribus calyculatis, petalis albis obovatis, antheris ovatis, luteis, erectis.*
Marginal notation: *"Narthecium pubens / Michx."*
Modern name: **Tofieldia racemosa** (Walt.) BSP.
Comments: Frequent in eastern South Carolina. The inflorescence with mostly 3-flowered nodes (*"pedunculis trifloris"*) is distinctive of *Tofieldia racemosa*, as are the obovate white tepals. There seems no reason for Walter's indication of doubt; the name *Melanthium racemosum* was original with him. Michaux (1803) used *Melanthium racemosum* differently, perhaps for *Veratrum virginicum* L. as suggested by Index Kewensis (Jackson 1893–1895). Other authors have been consistent in recognizing the transfer of Walter's epithet to *Tofieldia*; none has suggested invalidity on the basis that the query indicates Walter's failure to accept his new name (McNeill et al. 2006, Art. 34.1). No type specimen is known. A neotype has been selected elsewhere (Ward 2008b).

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BOOK REVIEW

TOM STANDAGE. 2010. **An Edible History of Humanity.** (ISBN 978-0-8027-1991-1, pbk.). Walker & Company, 175 Fifth Avenue, New York, New York 10010, U.S.A. (**Orders:** www.amazon.com or MPS Distribution Center, 16365 James Madison Highway, Gordonsville, Virginia 22942-8501, U.S.A., 1-888-330-8477). $16.00, 288 pp., 5 1/2" × 8 1/4"

In his book *An Edible History of Humanity*, Tom Standage leads readers through the buffet-line of history allowing an insight into the past which so many previous writers of this genre have neglected. Standage focuses on a dimension of history in which the affect food has on a civilization takes precedence. In this way Standage brings to light the enormous impact food has had on trade, politics, and war. *An Edible History of Humanity* offers a sampling of food's influence on the world's most notorious historical events and figures such as the spice trade, Columbus, and even the collapse of the Soviet Union. Standage mixes in a most refreshing and unique blend of flavorful information which will keep readers enthralled as they come across each savory addition to their knowledge-base of history.

Well-written and refreshing, *An Edible History of Humanity* is a must read for any history buff or foodie.—*Quincy Meeker, BRIT volunteer, Georgetown, Texas, U.S.A.*

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ACRONYMS FOR RECENTLY PROPOSED ANGIOSPERM FAMILIES

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ABSTRACT

Nine additional 3-letter acronyms are proposed for these angiosperm families.

RESUMEN

Se proponen acrónimos adicionales de tres letras para nueve familias de angiospermas.

Standardized abbreviations have been proposed for all vascular plant families (Kiger & Reveal 2000, 2009). The complete list of 3-letter acronyms is being maintained and updated by the Colorado Native Plant Society (see http://www.conps.org/pdf/Plant%20Keys/ACROS.pdf). Two recent publications have appeared that proposed new angiosperm family names (Nickrent et al. 2010; Schaéferhoff et al. 2009). Given that these acronyms are seeing wide usage among herbarium curators and others, it is important to now link each name with a unique acronym. The proposed acronyms are:

Amphorogynaceae (AMP)
Cervatesiaceae (CER)
Comandraceae (COM)
Coulaceae (COU)
Microteaceae (MCT)
Nanodeaceae (NAD)
Strombosiaceae (STB)
Thesiaceae (THI)
Ximeniaceae (XIM)

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BOOK REVIEW

Paul Martin Brown. 2008. **Lady's-slippers in Your Pocket: A Guide to the Native Lady's-slippers Orchids, *Cypripedium*, of the United States and Canada.** (ISBN 1-58729-655-1, pbk.). University of Iowa Press, 119 W Park Road, 100 Kuhl House, Iowa City, IA 52242-1000, U.S.A. (**Orders:** www.uiowapress.org, 1-800-621-2736, 1-800-621-8476 fax). $9.95, pocket guide, selection of color images, plant descriptions, and basic key, 4 1/8" × 9" folds out to 16 3/4" × 16 7/8".

Paul Martin Brown. 2008. **Ladies'-tresses in Your Pocket: A Guide to the Native Ladies'-tresses Orchids, *Spiranthes*, of the United States and Canada.** (ISBN 1-58729-656-X, pbk.). University of Iowa Press, 119 W Park Road, 100 Kuhl House, Iowa City, IA 52242-1000, U.S.A. (**Orders:** www.uiowapress.org, 1-800-621-2736, 1-800-621-8476 fax). $9.95, pocket guide, selection of color images, plant descriptions, and basic key, 4 1/8" × 9" folds out to 16 3/4" × 16 7/8".

These laminated, foldable guides consist of a series of plant descriptions and images of the most common species of either *Cypripedium* (Lady's-slippers Orchids) or *Spiranthes* (Ladies'-tresses Orchids) found in the United States and Canada. Each description includes a color image with the common and scientific name. For the *Cypripedium* guide, most of the descriptions include information regarding plant height, range, blooming season, and brief habitat notes for twelve species, two varieties, and six hybrids. Only some of the images included the habitat and a close-up of the flower. The *Spiranthes* guide format is similar; however, it includes more information regarding flower and leaf descriptions for twenty-six species, three varieties, and seven hybrids. The images within this guide consisted of close-ups of the flower.

Compactable, lightweight, and weatherproof, these guides could come in handy for the novice orchid hunter. The short dichotomous keys are straight-forward, and the detailed images should make identification of these two orchid-types a breeze. I would suggest both guides for any person eager to learn more about the possible *Cypripedium* or *Spiranthes* orchids in their area. I mean, at this price and size, why not?—*Keri McNew Barfield, MS Biology, Research Programs Manager, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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CORRIGENDA:

THE REINSTATEMENT OF *BEAUTEMPSIA* (CAPPARACEAE) AND A KEY TO THE GENERA OF NEOTROPICAL CAPPARACEAE WITH VARIOUSLY STELLATE TO PELTATE INDUMENTA

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Corrigenda

Beautempsia avicennifolia (Kunth) Alleiz. has been cited in the abstract and legend of Figure 1. The correct authorship of that species is *Beautempsia avicennifolia* (Kunth) Gaudich., as it is cited in the text of the same article.

REFERENCE

Cornejo, X. and H.H. Iltis. 2009. The reinstatement of *Beautempsia* (Capparaceae) and a key to the genera of neotropical Capparaceae with variously stellate to peltate indumenta. J. Bot. Res. Texas 3(2):683–689.

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BOOK REVIEW

Charles R. Hart, Barron Rector, C. Wayne Hanselka, Robert K. Lyons, and Allan McGinty. 2008. **Brush & Weeds of Texas Rangelands.** (ISBN 0-9721049-4-1, pbk.). Distributed for Texas AgriLife Extension Service by Texas A&M University Press, John H. Lindsey Building, Lewis Street, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** http://agrilifebookstore.org, www.tamu.edu/upress, 1-800-826-8911). $25.00, 203 pp, 406 color images, preface, 97 maps, plant descriptions, and general index, 5 1/2" × 8 1/2".

Brush & Weeds of Texas Rangelands consists of a series of plant descriptions about the common plants found on Texas rangelands. The plants are organized alphabetically by common name. After the preface, the authors provide a map of Texas that displays the ten vegetational areas of Texas. A smaller version of this map is included within the heading of each plant description. These smaller maps are only color coded for the specific regions where that particular plant is located.

Each plant description includes the common name, scientific name, family name, brief description, distribution, and habitat. On the opposing page are several color images of the plant. The authors attempt to remain consistent in their image choice, depicting for most plants separate images of the flower, whole plant, leaf, and population. Unfortunately, not all images are of equal quality. Some appear blurry or are of such poor composition that it is hard to distinguish the plant from the surrounding vegetation.

In general, plants are referred to by their common names, and this sometimes to extremes. For example, if a particular genus is very common, such as *Celtis* or *Rubus*, the authors simply use the common name (here, elm and blackberry) and provide a single, common description for the entire genus. At the end of the book, the authors provide a detailed list of the plants found in each of the vegetational regions of Texas.

This book provides both plant lovers and botanists, from novice to expert, with enough information to determine a particular plant found in the rangeland of Texas to genus or even species. The inclusion of a plant's value to livestock within many of the descriptions was a nice touch. A minor suggestion to the authors would be to include more information about those species found within common genera for one to be able to determine exactly which species they have encountered, as subtle differences among species could potentially spell the difference between forage, feed, and financial loss to a rancher. Overall, this book was very easy to understand, and I would easily suggest this for a person eager to learn about plants in Texas. It was also very lightweight, making it a perfect guide to take with you into the field.—*Keri McNew Barfield, MS Biology, Research Programs Manager, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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FLOURENSIA ILICIFOLIA (COMPOSITAE: HELIANTHEAE), NUEVO REGISTRO PARA DURANGO Y SEGUNDA ZONA DE DISTRIBUCIÓN PARA LA ESPECIE

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RESUMEN

Flourensia ilicifolia Brandegee (Compositae), conocida previamente sólo para el sur de Coahuila, se registra para la sierra El Sarnoso, en el sureste del estado de Durango, México. Se presenta una clave para identificación de especies de *Flourensia* de Coahuila y Durango.

Palabras clave: *Flourensia*, Coahuila, Durango, endemismo

ABSTRACT

Flourensia ilicifolia Brandegee (Compositae), previously known only from southern Coahuila, Mexico, is here recorded for the sierra El Sarnoso, in southeastern Durango. A key for identification of *Flourensia* from Coahuila and Durango is presented.

Key Words: *Flourensia*, Coahuila, Durango, endemism

Flourensia DC. (Compositae: Heliantheae), comprende alrededor de 30 especies americanas distribuidas principalmente en regiones áridas y semiáridas, con distribución disyunta (Rzedowski y Calderón de Rzedowski 2008), del suroeste de Estados Unidos a Centroamérica (Strother 2006) y de Perú a Chile y Argentina. Son arbustos, subarbustos o pequeños árboles aromáticos, usualmente glutinosos, de hojas alternas, simples. Cabezuelas con involucro de brácteas en 2 a 5 series; receptáculo con páleas rodeando a los aquenios; flores liguladas presentes o ausentes, flores del disco hermafroditas, amarillas; aquenios seríceos o a veces glabros, con vilano de (1)2(4) aristas, rara vez ausente.

En el presente trabajo se registra una extensión de la distribución de *Flourensia ilicifolia* Brandegee y se presenta una clave (adaptada de Dillon 1984) con el fin de facilitar el reconocimiento de las especies de *Flourensia* de Coahuila y Durango. *Flourensia ilicifolia* se describió en 1906 de cerca de Parras, en el sur de Coahuila (Blake 1921; Dillon 1984); desde entonces solo se conoce de algunos puntos en los alrededores de esa localidad y ha sido considerada como endémica para el sur de Coahuila (Villaseñor 1991; Villarreal-Quintanilla 2001; Villarreal-Quintanilla y Encina-Domínguez 2005). La especie se registra ahora para la sierra El Sarnoso, al oriente del estado de Durango. A pesar de que la distancia entre la localidad de Durango y las localidades conocidas en Coahuila no rebasan los 140 km en línea recta, se considera de interés dar a conocer este nuevo registro que amplía su distribución hacia el occidente de la región fisiográfica Pliegues Transversales (Villarreal Quintanilla et al. 1996) a través del Desierto Chihuahuense. Con esto, el área de endemismo de *F. ilicifolia* pasa de ser local a regional (Rzedowski 1991). Otra especie conocida para la Sierra de Parras y otras serranías de Coahuila (Villarreal-Quintanilla y Encina-Domínguez 2005) que ha sido recientemente reportada para el oriente de Durango es *Agave parrasana* Berger (González Elizondo et al. 2009), aunque en este caso la especie está restringida a las partes altas de las sierras.

Flourensia ilicifolia y *Agave parrasana* pertenecen a un contingente de especies cuya área de distribución

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conocida se ha ampliado gracias al mejor conocimiento florístico de la zona. Es probable que una mayor exploración permita ampliar las distribuciones de otros taxa de la misma región pero de distribución aún más restringida, como son los conocidos únicamente para las sierras de El Rosario y/o El Sarnoso en el NE de Durango y de Jimulco y Las Delicias en el W de Coahuila: *Justicia decurvata* Hilsenb., *Ruellia jimulcensis* Villarreal, *Henricksonia mexicana* B.L. Turner, *Coryphantha durangensis* (Runge ex K. Schum.) Britton & Rose, *Mammillaria stella-de-tacubaya* Heese, *Bernardia myricifolia* (Scheele) S. Watson var. *incanoides* M.C. Johnst., *Cnidoscolus shrevei* I.M. Johnst., *Pomaria fruticosa* (S. Watson) B.B. Simpson, *Eucnide durangensis* H.J. Thomps. & A.M. Powell, *Batesimalva lobata* Villarreal & Fryxell, *Sphaeralcea reflexa* Fryxell, Valdés-Reyna & Villarreal, *Clematis coahuilensis* D.J. Keil, *Vauquelinia californica* (Torr.) Sarg. ssp. *retherfordii* (I.M. Johnst.) W.J. Hess & Henr. y *Solanum johnstonii* Whalen (Villarreal-Quintanilla et al. 2005). Muchos otros taxa se añadirían a la lista si el área se extiende para incluir el extremo N de Zacatecas, el SE de Chihuahua, la cuenca media del río Nazas en Durango, u otras serranías de Coahuila. La importancia del Desierto Chihuahuense como concentrador de endemismos, particularmente para la familia de las compuestas, ha sido discutida por Rzedowski (1972). El oriente de Durango en particular presenta dos zonas de endemismos: la cuenca del río Nazas (González et al. 2000) y las sierras de El Sarnoso y El Rosario, de importancia biogeográfica por representar el extremo occidental de las Serranías Transversales que atraviesan el Desierto Chihuahuense a partir de la Sierra Madre Oriental.

Flourensia ilicifolia es abundante y aún dominante fisonómicamente en algunos sitios de la nueva localidad registrada, donde se acompaña de *Acacia constricta* var. *vernicosa, Acacia* sp., *Fouquieria splendens, Agave asperrima, Yucca torreyi, Tetracoccus fasciculatus* y *Dasylirion* sp. Se desarrolla en sitios con fuerte afloramiento rocoso, en suelo somero, arenoso o con grava, amarillento, entre los 1300 y 1400 m snm. En Coahuila, se conoce para áreas cercanas a la sierra de Parras, en matorrales micrófilo y rosetófilo en valles y laderas con suelo pedregoso entre los 1150 y 2000 m.

Ejemplares de respaldo (vouchers) para Durango: **MÉXICO. Durango:** municipio de Mapimí, sierra El Sarnoso, Dinamita, 25°44'09"N, 103°40'57"W, 1300 m, 25 May 2005, *J. Alemán 9* (CIIDIR); Mapimí, sierra El Sarnoso, Valle de las Piedras Encimadas, 25°42'07"N, 103°42'30"W, 1400 m, 8 Jun 2006, *S. González 7156 con L. López, J. Sánchez, J. Alemán* (ANSM, CIIDIR, IEB, MEXU, UJED).

Las plantas de Durango son arbustos de alrededor de 1 m de alto, con hojas similares a las descritas para *F. ilicifolia* pero con flores con lóbulos de la corola que van de cortos (0.8 mm de largo) como en *F. dentata* a largos (hasta 2 mm), como los típicos de *F. ilicifolia*. *Flourensia ilicifolia* y *F. dentata* son especies estrechamente relacionadas. Son las únicas dos especies norteamericanas del género que tienen hojas dentadas (ocasionalmente en *F. microphylla* el margen es diminutamente aserrado) y se consideran derivados primitivos de la línea de *Flourensia cernua* DC., el hojasén u hojasé, una de las especies más abundantes en el Desierto Chihuahuense (Dillon 1984).

CLAVE PARA IDENTIFICACIÓN DE ESPECIES DE *FLOURENSIA* DE COAHUILA Y DURANGO

1. Cabezuelas discoideas (sin flores liguladas).
  2. Hojas de margen entero, a veces ondulado.
    3. Cabezuelas solitarias sobre pedúnculos de (8–)13 a 20 cm de largo; brácteas del involucro en alrededor 4 a 5 series; aquenios glabrescentes a puberulentos, sin vilano __________ **Flourensia solitaria** S.F. Blake
    3. Cabezuelas en grupos espiciformes o cimosos, pedúnculos de 0.5 a 2 cm de largo; brácteas del involucro en 2 a 3 series; aquenios seríceos, vilano de dos cerdas aristiformes.
      4. Hojas ovadas a elípticas,1.1–2.5(–3) cm de largo; cabezuelas a lo largo de ramillas con hojas __________ **Flourensia cernua** DC.
      4. Hojas estrechamente elípticas a lanceoladas, (1.8–)2.5–7.5 cm de largo; cabezuelas en inflorescencias cimosas terminales __________ **Flourensia retinophylla** S.F. Blake
  2. Hojas dentadas o iliciformes.
    5. Hojas rómbico-ovadas, 8–25 mm de ancho, márgenes con 3–6 pares de dientes rígidos y mucronados; lóbulos de la corola (0.8–)2–2.5(–3) mm de largo __________ **Flourensia ilicifolia** Brandegee
    5. Hojas elíptico-ovadas a lanceoladas, 4–10(–16) mm de ancho, márgenes con 1–5 pares de dientes emucronados a veces alargados como lóbulos; lóbulos de la corola 0.5–0.8 mm de largo __________ **Flourensia dentata** S.F. Blake

1. Cabezuelas radiadas (con flores liguladas).

6. Hojas 1.5–2.5 cm de largo, 0.5–1 cm de ancho, pecíolos híspido-pilosos por lo menos en la base; cabezuelas jóvenes con involucro híspido-piloso ______ **Flourensia microphylla** (A. Gray) S.F. Blake

6. Hojas (2–)5–12(–15) cm de largo, 1–4.5 cm de ancho, pecíolos no híspido pilosos; cabezuelas jóvenes con involucro glabrescente o glabro.

7. Subarbustos con tallos erectos poco ramificados; lígulas 13–21, 10–16 mm de largo x 3–4 mm de acho; flores del disco 40–50 ______ **Flourensia pringlei** (A. Gray) S.F. Blake

7. Arbustos muy ramificados desde la base; lígulas (10–)13(–15), 20–30 mm de largo x 5–7 mm de acho; flores del disco 50–60(–150).

8. Brácteas externas del involucro 9–13 mm de largo; hojas 6–11.5 cm de largo, 2–4.5 cm de ancho, estrigosas; plantas de bosque de pino-encino, Coahuila y Nuevo León ______ **Flourensia monticola** M.O. Dillon

8. Brácteas externas del involucro 18–20 mm de largo; hojas (5–)8–12(–15) cm de largo, 2–3 cm de ancho, puberulentas; plantas de matorral submontano, Chihuahua, Coahuila y Durango ______ **Flourensia pulcherrima** M.O. Dillon

De las ocho especies incluidas en la clave, *F. monticola* se encuentra en la Sierra Madre Oriental y las restantes se encuentran en el Desierto Chihuahuense o en serranías dentro de esa región, que en su parte de Coahuila y Durango parece representar el centro de diversificación del género. Además de estas especies, se conocen para México las siguientes: *Flourensia collodes* (Greenm.) S.F. Blake, de bosque tropical caducifolio en Oaxaca y Chiapas; *F. glutinosa* (Robinson et Greenm.) S.F. Blake, de Puebla y Oaxaca (Dillon 1984); *F. laurifolia* DC., de matorral tamaulipeco, matorral submontano y bosque tropical caducifolio del sur de Tamaulipas a Guanajuato, Querétaro e Hidalgo y *F. resinosa* (Brandegee) S.F. Blake, de la zona árida queretano-hidalguense, la porción sur de la zona árida Chihuahuense (Rzedowski 1978; Rzedowski y Calderón de Rzedowski 2008).

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DIVERSITY AND ABUNDANCE OF ORCHIDS IN A PERUVIAN CLOUD FOREST

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ABSTRACT

Although there is considerable diversity among the orchids of the Peruvian cloud forests, there is little quantitative data on species abundances and distributions. Most information is limited to local species lists, which have sometimes been incomplete and sometimes based on varying taxonomic sources. This study, which lasted from September 2005 until August, 2006, was designed to provide a comprehensive assessment of orchid diversity and abundances within a 560-ha cloud forest reserve northwest of Cusco. It involved intensive monthly collections of flowering orchids to assess biodiversity and monthly analyses of orchid diversity, abundances, and flower phenologies in 47 permanent, 5m by 5 m plots. Monthly collections identified 239 morphospecies within the 560 ha reserve with 130 of these identified as previously named species. Of the 239 morphospecies, only nine could be termed abundant based on their occurrence in more than 1/3 of the permanent plots or their mean density being > 2 individuals / m^2. There was little apparent overlap in species composition of the orchid flora at this site with those observed in similar studies at Machu Picchu and Manu National Park sites. Moreover, few of the nine abundant orchid species were abundant or even present at other sites. Although communality, formation of a species community, among abundant neotropical tree species has been suggested for broadly dispersed sites in western Amazonia, this study found little evidence of a similar communality in the orchid flora of these Peruvian cloud forests.

Key Words: Orchidaceae; Andes; cloud forests; diversity; abundance; phenology; Wayqecha Biological Field Station

RESUMEN

Aunque hay una diversidad considerable entre las orquídeas de las nefosilvas[3] peruanas, hay pocos datos cuantitativos sobre las abundancias y distribuciones de las especies. La mayor parte de la información está limitada a listas especies locales, que a veces son incompletas y a veces basadas en fuentes taxonómicas heterogéneas. Este estudio, que se desarrolló de Septiembre de 2005 a Agosto de 2006, fue diseñado para hacer una valoración exhaustiva de la diversidad y abundancia de orquídeas en una reserva de nefosilva de 560-ha en el noroeste de Cusco e implicó colecciones intensivas mensuales de orquídeas en flor para valorar la diversidad análisis mensuales de la diversidad de orquídeas, abundancias y fenología floral en 47 parcelas permanentes de 5m por 5 m. En las colecciones mensuales se identificaron 239 morfoespecies en las 560 ha de reserva con 130 de estas identificadas como especies nombradas previamente. De las 239 morfoespecies, sólo nueve pudieron ser calificadas como abundantes basándonos en su aparición en más de 1/3 de las parcelas permanentes o su densidad media > 2 individuos / m^2. Hubo poco solapamiento aparente en la composición de especies de la flora orquidológica de este lugar con la observada en estudios similares en Machu Pichu y en el Parque Nacional de Manu. Más aún, pocas de las nueve especies de orquídeas eran abundantes o estaban presentes en los otros sitios. Aunque entre especies arbóreas neotropicales se ha sugerido que son comunes para zonas amplias el oeste de Amazonia, Este estudio encontró pocas pruebas de un comportamienteo similar en la flora orquidológica de estas nefosilvas peruanas.

The Orchidaceae is one of the largest families of flowering plants (Stebbins 1981; Gentry 1988; Gravendeel et al. 2004) with at least 1,000 mostly epiphytic species occurring in Peru alone (Iblish et al. 1996). The high Peruvian species diversity of orchids, especially that of epiphytic orchids in Andean cloud forests, has been recognized and explored for years. A common orchid from the Peruvian Andes, *Epidendrum secundum*,

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[3] **Se propone el término nefosilva para designar los bosques que se desarrollan en lugares de niebla (en inglés *cloud forest*). Las dos partes que componen la palabra ya se usan en el lenguaje científico.**

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was first characterized in 1760 (Rolfe 1916). In 1911, Hiram Bingham described the Machu Picchu site and commented on the orchids occurring there (Christenson 2003). This high orchid diversity occurs due to a mixture of conditions including (1) a cool, moist climate favorable to epiphytes, (2) the diversification of isolated populations on separate mountain ranges (Tremblay et al. 2005), and (3) the ability of orchid species to easily hybridize (Tremblay et al. 2005).

Although this diversity has been recognized, there is limited quantitative information on the species richness and spatial distribution of orchids across sites and along elevation gradients in the Peruvian Andes. More is known about how these factors affect epiphytes in general than orchids in particular. These montane forests harbor a high diversity and abundance of epiphytic plant species (Grubb et al. 1963; Cornelissen & Ter Steege 1989) with maximum species richness and endemism occurring in wet aseasonal forests on fertile soils at elevations of 1500 to 2000 masl (Gentry & Dodson 1987; Iblish et al. 1996; Kessler, 2002; Kuper et al. 2004; van der Werff & Cosiglio 2004; Kromer et al. 2005). Species richness declines above 2000 m asl but whether this decline indicates some climatic optimum or merely reflects the decline in available land mass above this elevation remains unclear (Kromer et al. 2005). Orchid diversity generally follows the trends for all epiphytes (Kessler 2002; Kuper et al. 2004; Kromer et al. 2005), but the pattern may vary among orchid genera (Kessler 2002).

Detailed studies of orchid diversity and distribution at cloud forest elevations are limited to two studies in southeastern Peru. One was a 12-month study in a 143.5-hectare section on the Machu Picchu Historical Sanctuary (MPHS) near the Winay-Wayna structures (WW; Zambrano et al. 2003a). The other was a 12-month inventory of 16 100-m^2 plots in the Manu National Park (MNP; Zambrano et al. 2003b). Both studies report more than 170 orchid species, with limited overlap with the extensive species list compiled by numerous investigations at the MPHS (Christenson 2003). These two studies suggest a diverse orchid flora composed of numerous species that may have limited spatial distributions. Although these studies document high species diversity at each site and high site-to-site variability in species composition, neither study assesses the relative abundances of the various orchid species. Comparison of the variability in species compositions among these studies is also complicated by potential problems in nomenclature that are difficult to resolve because of the lack of access to reference specimens, digital imagery, or detailed collection data.

The present extent of our understanding of Andean orchid diversity is similar to those that existed for western Amazonian tree floras before the advent of quantitative studies of species abundances. Based on early compilations of species lists at different sites, the forests could be depicted as small-scale mosaics of relatively unpredictable species composition. As quantitative studies were performed following the recommendations of Phillips and Raven (1996) and others, patterns of structure involving some widely dispersed, commonly occurring, and relatively abundant taxa could be recognized (Pitman et al. 2001; Macia & Svenning 2005). Although some studies have not provided strong support for the existence of such widespread communality, formation of a species community, of abundant tree species (e.g., Phillips et al. 2003; Tuomisto et al. 2003; Vormisto et al. 2004), they have demonstrated that testing for the presence, or the absence, of such communality requires abundance as well as species composition be documented.

This study had two main goals. First, to initiate quantitative assessments of orchid diversity and abundance in cloud forests similar to those employed for Amazonian tree flora, and second to compare the results to other detailed studies of cloud forest orchid diversity in southeastern Peru to determine possible communalities in abundant taxa. The specific objectives of the study were to: (1) determine orchid species richness; (2) estimate the relative abundances of species; and (3) question whether the abundant orchid species at this site were also abundant, or at least present, at other research sites in the region. In addition, data were obtained to assess the effects of elevation and different habitats on patterns of local orchid diversity and abundance. If elevations and habitats have large effects, they could contribute to heterogeneity in species compositions and abundances.

METHODS

The design of this study emulates the general protocols recommended by Phillips and Raven (1996) for assessing tree diversity in the Neotropics. These protocols share procedures designed to quantify diversity on a local scale by obtaining: (1) a more complete inventory of plant species composition; (2) an assessment of the spatial distribution of species; and (3) basic phenological information. These objectives are accomplished by conducting surveys to document the species composition and by monitoring of permanent plots for species abundances. For orchids, these objectives were addressed between September, 2005 and August, 2006 through monthly, systematic collections of the orchid species present and the monthly monitoring of permanent plots to measure diversity, distribution, and abundance of the species present. Because the study involves the application of new protocols to quantify orchid abundance and diversity, an evaluation of these protocols with recommendations for potential modifications are also discussed.

Study site.—Research was conducted at the 560-ha Wayqecha Cloud Forest Research Station (WCFR; 13°10'40"S, 71°36'20"W) located 60 km northeast of Cusco in southeastern Peru (Fig. 1). The station borders Manu National Park and is owned and operated by the Amazon Conservation Association (ACA) of Washington, DC and its sister organization in Peru, the Asociación para la Conservación de la Cuenca Amazónica (ACCA). Elevations at WCFR range from 2200 to 3200 m, and the primary natural vegetation is upper montane forest (Young & León 2000). The forest is continually saturated with rain and fog. Temperatures average 11°C with little seasonal variation. Precipitation ranges from < 10 mm in the months of June and July to > 100 mm in the months of January, February, and March.

Systematic plant collection.—To document the orchid species occurring at WCFR, approximately 10 days of each month were devoted to collecting, photographing, and preserving specimens of flowering orchids. Every orchid with a unique vegetative or reproductive morphology was considered to be a potential new morphospecies unless it could be positively identified as belonging to a previously collected type. Although this practice resulted in replicate collections of some orchid species, it minimized the number of missed species.

One or more specimens were collected for each potentially new morphospecies. At least one specimen was deposited in the herbarium of the Museo Nacional Mayor de Historia Natural (USM) in Lima, Peru. Another specimen was deposited in the herbarium of the Botanical Research Institute of Texas (BRIT) in Fort Worth, Texas, and additional specimens were dispersed to orchid experts at other herbaria. Flowers were also collected and preserved in 80% alcohol and 20% glycerine and deposited at BRIT.

Each potential morphospecies was assigned an identification number, and pertinent data were recorded including: (1) date of collection; (2) location as determined by a Garmin Map76C global positioning system unit (GPS, nominal accuracy < 15 m); (3) relative flower size (1 to 5, 5 being the largest); (4) color of the flower (particularly lip and column colors); and (5) habit (terrestrial or epiphytic). The habitat of the individual was also classified as: (1) tall cloud forest with tree heights > 15 m; (2) short cloud forest with tree heights < 15 m; and (3) grassy areas with no trees or few trees with heights < 3 m. Grassy areas likely resulted from disturbances, such as logging, road construction, or fire over the past 60 years (Young & León 2000; Lozano et al. 2006). To aid in species identification, ≥8 mega-pixel digital photographs were taken for each potential morphospecies. Collection data and digital photographs are accessible through the Atrium Biodiversity Information System at BRIT (http://atrium.andesamazon.org).

Upon completion of the field collections, specimens of potential morphospecies were compared in the herbarium and judged to be either a unique, valid taxon, or to be conspecific with another collected morphospecies. For those morphospecies judged to be conspecific, the collected specimens were combined into a single morphospecies. All morphospecies collections were reviewed by taxonomic experts to confirm their morphospecies status and to begin the process of species identification and description.

Quantitative data collection.—To analyze the effects of elevation and habitat differences on orchid diversity, abundance, and distribution, 47 permanent, 5 × 5 m plots were established across the elevation gradient within WCFR. Because of steep gradients and dense vegetation, the plots were established at ran-

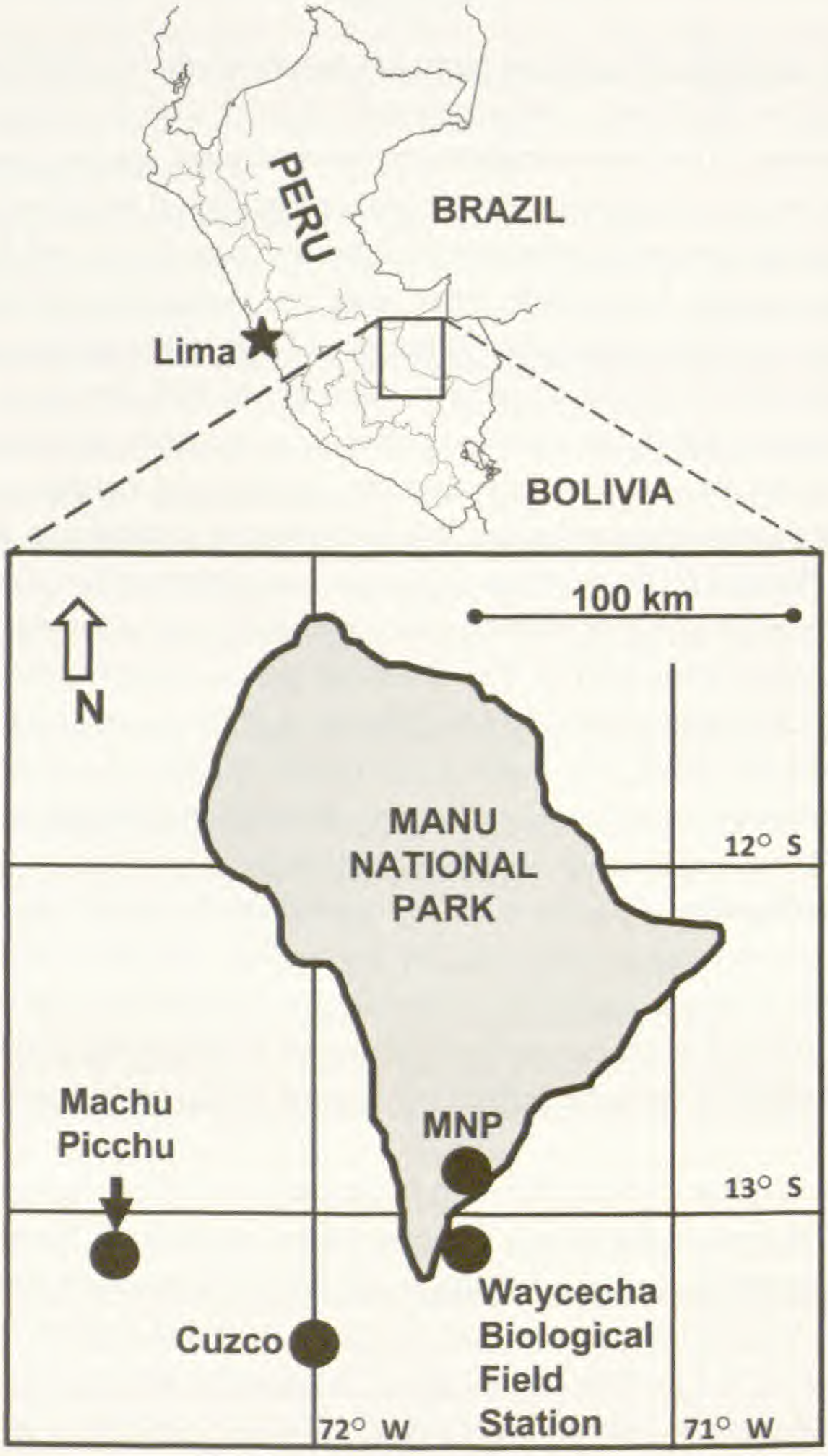

Fig. 1. The location of Wayqecha Biological Field Station (2200–3200 m) in southeastern Peru relative to the city of Cuzco, Machu Picchu, Manu National Park, and the study site of Zambrano et al. (2003b) denoted as MNP within Manu National Park.

dom locations along pre-existing trails passing through the characteristic forest and grassland habitats of the area. The latitude, longitude, and elevation of each plot were measured by GPS. Habitats were classified as tall cloud forest, short cloud forest, or grassy areas, as described above.

From September 2005 through August 2006 the plots were monitored between the 9th and the 13th of each month for the occurrence of potential morphospecies in flower. For the first occurrence of a potential morphospecies in a plot, the species was catalogued using its identification number from the general collection, and the number of individuals with flowers, total number of flowers, and whether the orchid was occurring as a terrestrial or epiphytic form was recorded. If a potential new morphospecies was first encountered in the plots, it was added to the general collection using the previously described procedures to collect suitable specimens located outside of the plot. If the orchid only occurred in the plot, only digital photographs were taken to assist in species identification. For subsequent monthly observations of a morphospecies in a plot, the number of individuals with flowers and the total number of flowers were recorded. General linear model tests of the effects of elevation and habitat type on the species richness and density of orchids were performed using the Statistical Analysis System (SAS; Cody & Smith 2006).

Limited resources and field conditions prevented each individual plant from being tagged, and it is possible that individuals counted as flowering in one month could also be counted as flowering in subsequent months. For this reason, the term density as used in subsequent discussions is a minimum estimate of density taken as the maximum number of individuals of that morphospecies observed flowering in that plot in any one month.

Rarefaction analysis.—To evaluate how well the plot sampling could estimate the species richness determined by systematic collections, rarefaction curves (Gotelli & Colwell 2001) were computed using the non-parametric species richness estimators Chao 1 (Chao 1984) and Chao 2 (Chao 1984, 1987). These procedures use the occurrence of rarer species in the samples to adjust the observed number of species for the number of species that were likely missed in the sampling. The Chao 1 procedure defines rareness as being represented by only a few individuals. The Chao 2 procedure defines rareness as being observed in only a few plots. Chao1 and Chao 2 estimators and their 95% CI were computed from 10,000 randomizations of plot sequences using the software EstimateS 8.0 (Colwell 2006). Other richness estimators were also computed and gave comparable results.

RESULTS

Systematic collections.—From the 341 potential morphospecies collected, 239 unique morphospecies were identified from 49 genera. Over 134 morphospecies have been identified as previously described species, and six other are new to science (Christenson & Repasky 2008; Nauray & Galán de Mera 2008). The remaining 102 morphospecies remain to be identified as previously named species or described as species new to science. It is important to note that the as yet unidentified taxa reported here are morphospecies based on structural characteristics which may not be supported by subsequent genetic analysis. However, it is also possible that subsequent genetic analyses may separate apparently similar orchids into separate species. The number of morphospecies per genus ranged from 41 for *Stelis* to < 2 species in 32 other genera. The number of morphospecies in the other common genera *Epidendrum*, *Maxillaria*, and *Pleurothallis* were three, six and nine, respectively. A species list organized by genus is presented in Appendix S1.

Monthly collections were important for adequately assessing orchid diversity as most species flowered for ≤ 3 months. Monthly importance is best illustrated by the flowering phenology data from the plot studies where only six of the 17 species flowering in September 2005 were among the 65 species observed to be flowering in February, 2006. Only six of the 65 species flowering in February were among the 23 species flowering in August, 2006.

Plot characteristics.—Plots ranged in elevation from 2496 to 2993 m, and when grouped into equal elevational intervals of 175 m, there were similar numbers of plots in each interval (Fig. 2). All three habitats were present in each interval.

Orchid densities and distributions.—The minimum number of individuals recorded in all of the plots for the duration of the study was 2565, which is the sum of the maximum number recorded in any month for a species in each plot. Minimum numbers of individuals per plot showed little variation with elevation or habitat type ($F = 0.33$; df = 5, 41; $P > 0.10$; Appendix S2). Mean (± Standard Deviation; SD) densities for grassy areas, short cloud forest, and tall cloud forest were 2.2 (± 1.1), 2.4 (± 1.2), and 1.9 (± 2.1) individuals per m^2, respectively. Densities declined with increasing elevations at a rate of 0.38 individuals per m^2 per 100 m of elevation, but this rate was not significantly different from 0. Densities were approximately normally distributed (Kolmogorov-Smirnov test of normality; Conover 1971).

Distribution of orchid species among plots.—Only 128 of the 239 species were observed in plots during the 12-month study. Because almost all orchid individuals observed in plots flowered during the study, this underrepresentation was due to inadequate sampling of the spatial heterogeneity of the orchid flora. The number of species per plot ranged from three to twenty-five with a median of nine species per plot. Most of the orchid species (72%) occurred as epiphytes.

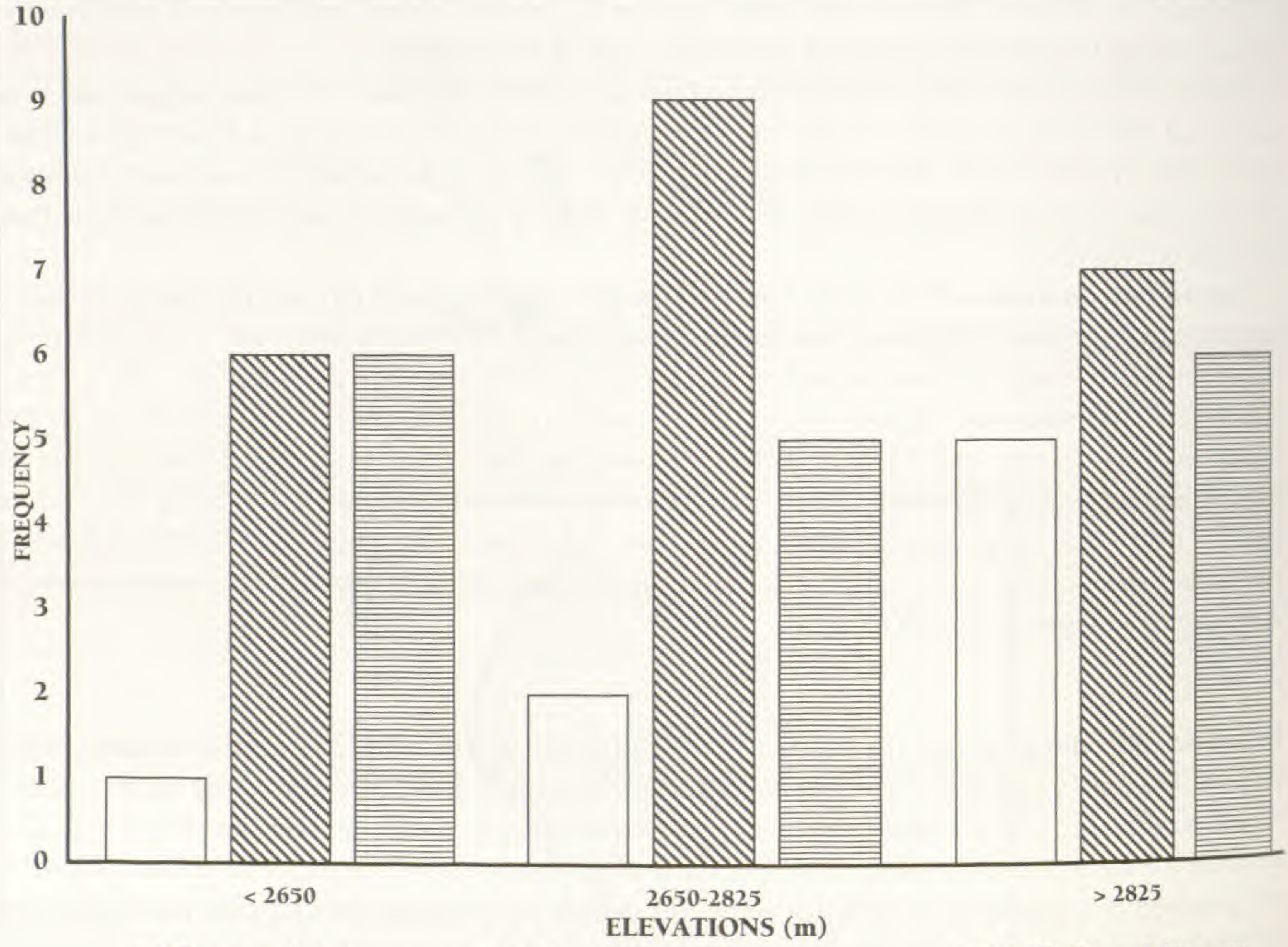

Fig. 2. The number of plots in each habitat type and elevation interval.

For terrestrial species, there were significant differences in the number of terrestrial species per plot among habitats ($F = 6.15$; df = 2, 43; $P < 0.01$) and at different elevations ($F = 14.09$; df = 1, 43; $P < 0.01$). The mean (± SD) number of terrestrial species per plot for tall cloud forest was 1.8 (± 2.5). This was significantly ($P < 0.05$) less than the means of 4.0 (± 2.7) species per plot in short cloud forest and 3.4 (± 2.6) species per plot in grassland. There was a decrease of 0.81 (SE = 0.22) terrestrial species per plot for each 100 m increase in elevation. The two terrestrial orchids with the highest frequency of occurrence, *Epidendrum secundum* and *Elleanthus sp.*, occurred in 17 of the 47 plots.

For epiphytic species, there were also significant differences in the number of species per plot among habitats ($F = 7.29$; df = 2, 43; $P < 0.01$) and at different elevations ($F = 19.12$; df = 1, 43; $P < 0.01$). The number of epiphytic species per plot for short cloud forest (10.1 ± 4.5) was significantly greater than that for the tall cloud forest (6.3 ± 3.7) and the grass areas (6.2 ± 4.0). For each 100 m increase in elevation, there was a decrease of 1.4 (SE = 0.3) epiphytic species per plot. The epiphytic orchid with the highest frequency of occurrence was *Pleurothallis acuminata* which occurred in 20 plots.

There was considerable variation among species in abundances and frequencies of occurrence. There were 27 species with an abundance of one individual and 12 species with an abundance of two. The majority of orchid species had mean densities < 2 per m^2. Only nine species had mean densities > 2 per m^2. These were listed in order of decreasing abundance, *Pachyphyllum* sp.1, *Pleurothallis* aff. *vestigipetala, Stelis breviracema, Elleanthus* sp. 1, *Stelis grandibracteata, Maxillaria alpestris, Epidenrum secundium, Pleurothallis acuminata* and *Pachyphyllum pectinatum*. Most (77%) species were observed in < 5 plots (Fig. 3). Forty-nine species were found in only one plot, and 22 species occurred in only two plots. Only six species were observed in > 30%

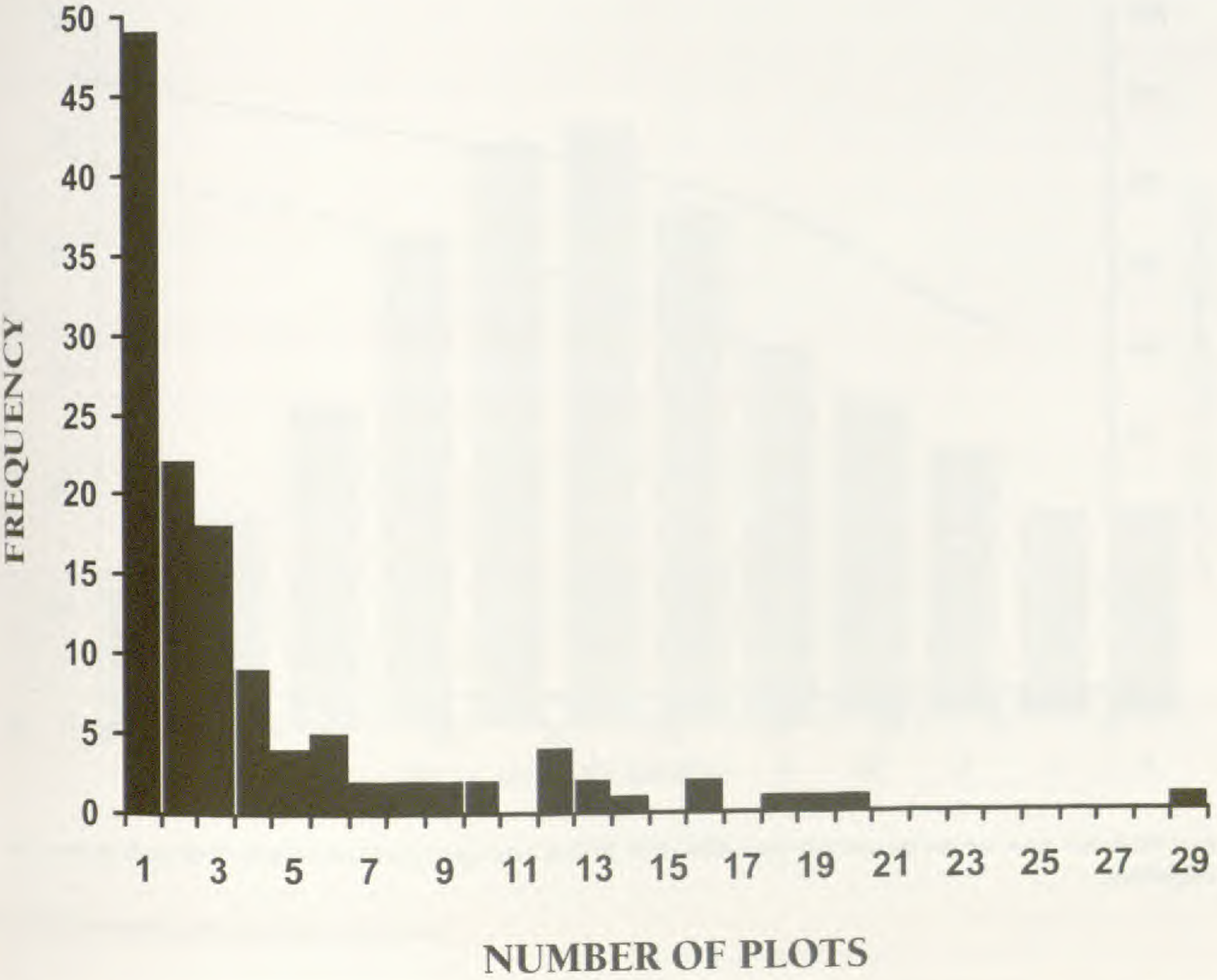

FIG. 3. The number of species occurrences per plot.

of the 10 plots. These, listed in order of decreasing frequencies of occurrence, were *Pachyphyllum* sp. 1, *Pleurothallis acuminata*, *Stelis breviracema*, *Epidendrum secundum*, *Elleanthus* sp. 1, and *Pachyphyllum pectinatum*.

Rarefaction Analysis.—Both the Chao 1 and Chao 2 procedures consistently underestimated the species richness of 239 observed in the systematic collections (Fig. 4). The Chao 2 procedure, which defines rareness based on incidences of occurrence, was consistently greater than the Chao 1 procedure, which defines rareness based on the abundance of individuals. The final estimate for the Chao 2 procedure, based on randomizations of all 47 plots, was 183 species with a 95% Confidence Interval (95% CI) of 155 to 240 species. The final estimate for the Chao 1 procedure was 158 species with a 95% CI of 140 to 206 species.

Flowering Phenology.—The percent of species in the plots that were in flower ranged from 13% in September to 51% in February (Fig. 5), and there was little differences in percents among habitat types or across elevations. The mean (± SD) density of flowers also ranged from a minimum of 0.65 (± 1.1) per m^2 in September to a maximum of 25.7 (± 37.6) per m^2 in February. Peak flowering occurred during months with > 100 mm of rainfall, and minimum flowering occurred in months with < 5 mm of rainfall. The median flowering duration was three months, and most (80%) species flowered for less than six months. The proportion of flowering species shared between successive months was ≤ 0.40 (Fig. 6), and there were no pronounced peaks in the proportions shared that indicated major subsets of species exhibiting synchronous flowering.

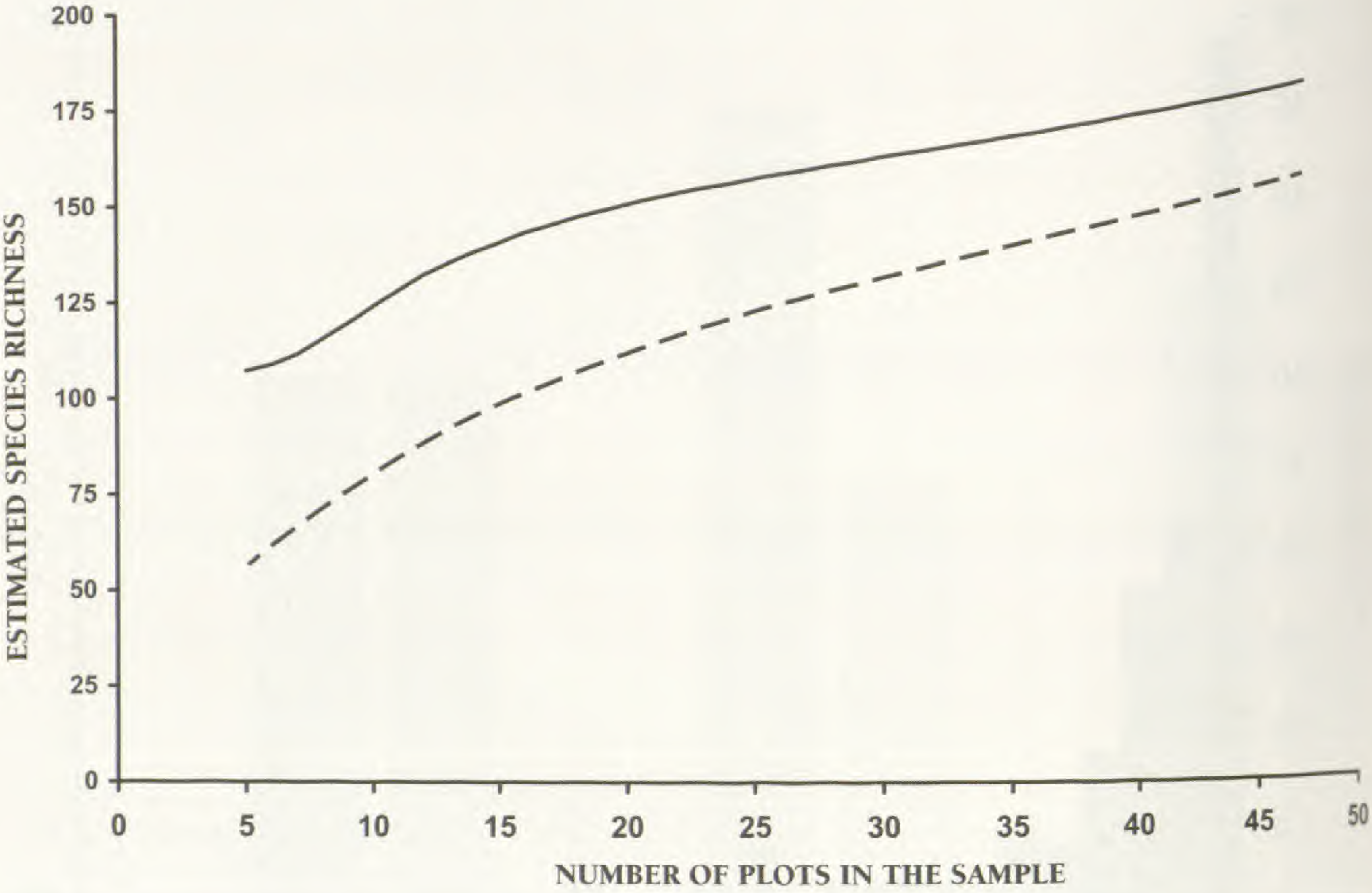

Fig. 4. Rarefaction curves showing the estimated species richness for the Chao 2 and Chao 1 procedures based on 10,000 randomizations of plot compositions.

DISCUSSION

The cloud forests at WCFR harbor a rich diversity of orchids with 130 species and 109 morphospecies, or 239 unique taxa, collected and documented during the 12-month sampling period. Most of the orchids were relatively rare. Over 75% of them were either found only during the systematic collections or only occurred in ≤ 2 of the 47 plots. Those that did occur in plots were often represented by ≤ 3 individuals. Only nine of the species could be described as being abundant due to their occurrence in more than one-third of the plots or their mean densities being > 2 individuals per m^2. These included the identified species *Epidendrum secundum*, *Maxillaria alpestris* aff., *Pachyphyllum pectinatum*, *Pleurothallis acuminata*, *Pleurothallis vestigipetala* aff., *Stelis breviracema*, and *Stelis grandibracteata* and the morphospecies *Elleanthus* sp. 1 and *Pachyphyllum* sp. 1. *Elleanthus* sp. 1 and *Epidendrum secundum* were primarily terrestrial species. The *Pachyphyllum* and *Pleurothallis* species were primarily epiphytes. The remaining three abundant species occurred with similar abundances in both terrestrial and epiphytic growth forms.

Similar intensive, 12-month assessments of orchid species richness in the Peruvian Andes have been made near the Winay-Wayna ruins (WW; Zambrano et al. 2003a) at MPHS which is about 100 km west of WCFR and in a small portion of Manu National Park (MNP; Zambrano et al. 2003b) to the northeast of WCFR. In addition to these intensive analyses of smaller sites, Christenson (2003) has compiled a species list for the 35,952-ha MPHS based on collections since that site's discovery in 1911. Comparing the species compositions of these sites and WCFR is complicated because: (1) the MNP and WW studies included orchid species from elevations above and below the cloud forest; (2) a number of unidentified or undescribed morphospecies still exist; and (3) variation in the use of nomenclature and taxonomic classifications among study sites and researchers. Despite these complications, three general trends in species richness and composition are apparent.

First, the intensive studies of small areas have found comparably large numbers of orchid species. There

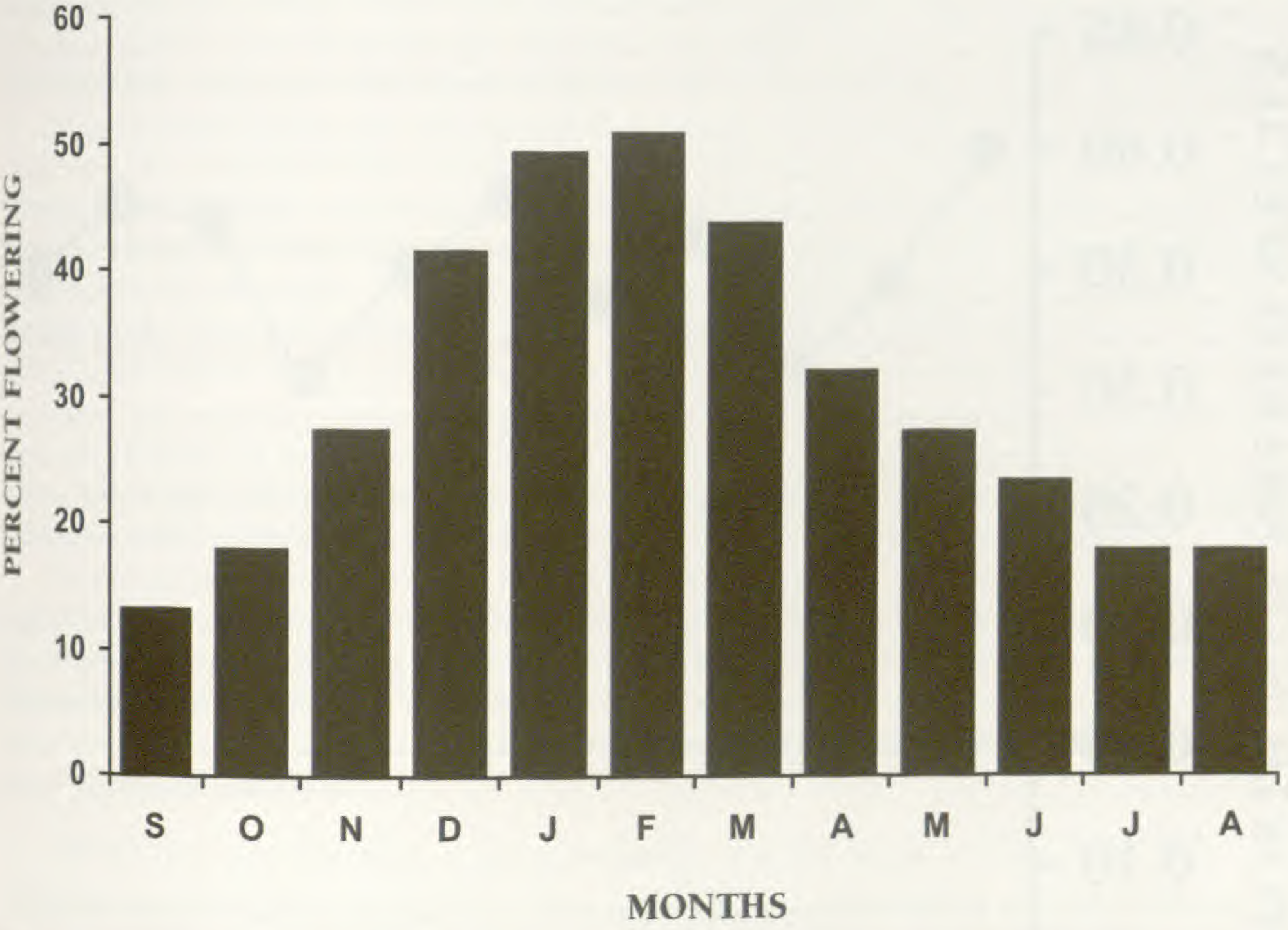

Fig. 5. The percentage of species flowering in each month.

were 212 species found at MNP and 179 at WW. These numbers are similar to the 239 species found at WCFR (Christenson 2003). The number of species at each of these sites is also similar to the 252 that have been reported for all of MPHS. As many as 50 species of epiphytic orchids have been found in 1-ha plots at cloud forest elevations (Kromer et al. 2005).

Second, most of the species occurring at the intensely studied sites belong to the large genera *Epidendrum*, *Maxillaria*, *Pleurothallis* and *Stelis*, but there is variability in the relative importance of these genera among sites. *Epidendrum* is the most numerous genus at the MNP and WW sites, but *Stelis* is the most numerous genus at WCFR. *Epidendrum* is the second most diverse genus at WCFR, but *Stelis* is less diverse than the other three genera at the MNP and WW sites.

Third, although the important genera appear to be similar across sites, the species representing these genera differ among sites. No species list is provided for the WW site, but Zambrano et al. (2003b) listed the 63 species that occurred at MNP which are also known to occur at MPHS. Apparently, the remaining 149 species at MNP could not be matched to MPHS species. Of those 63 species common to MNP and MPHS, only 28 occurred at WCFR. Thirty-six of the 63 species common to MNP and MPHS were members of *Epidendrum*, *Maxillaria*, *Pleurothallis* and *Stelis*, but only 17 of these occurred at WCFR.

There are other differences in species compositions between WCFR and MPHS. Of the 79 genera reported for both WCFR and MPHS (Christenson 2003) only 43 occur at both sites, and 25 of these are represented at WCFR by only a single species. For those genera represented by numerous species at WCFR, there were six *Epidendrum* species, 16 *Maxillaria* species, and six *Pleurothallis* species that are not reported from MPHS. Additional species that occur at WCFR but not at MPHS may be discovered as progress is made on accurate identifications of the numerous morphospecies in the difficult *Stelis*. In addition, a number of WCFR species are new additions to the flora of Peru or previously undescribed species (Christenson & Repasky 2008).

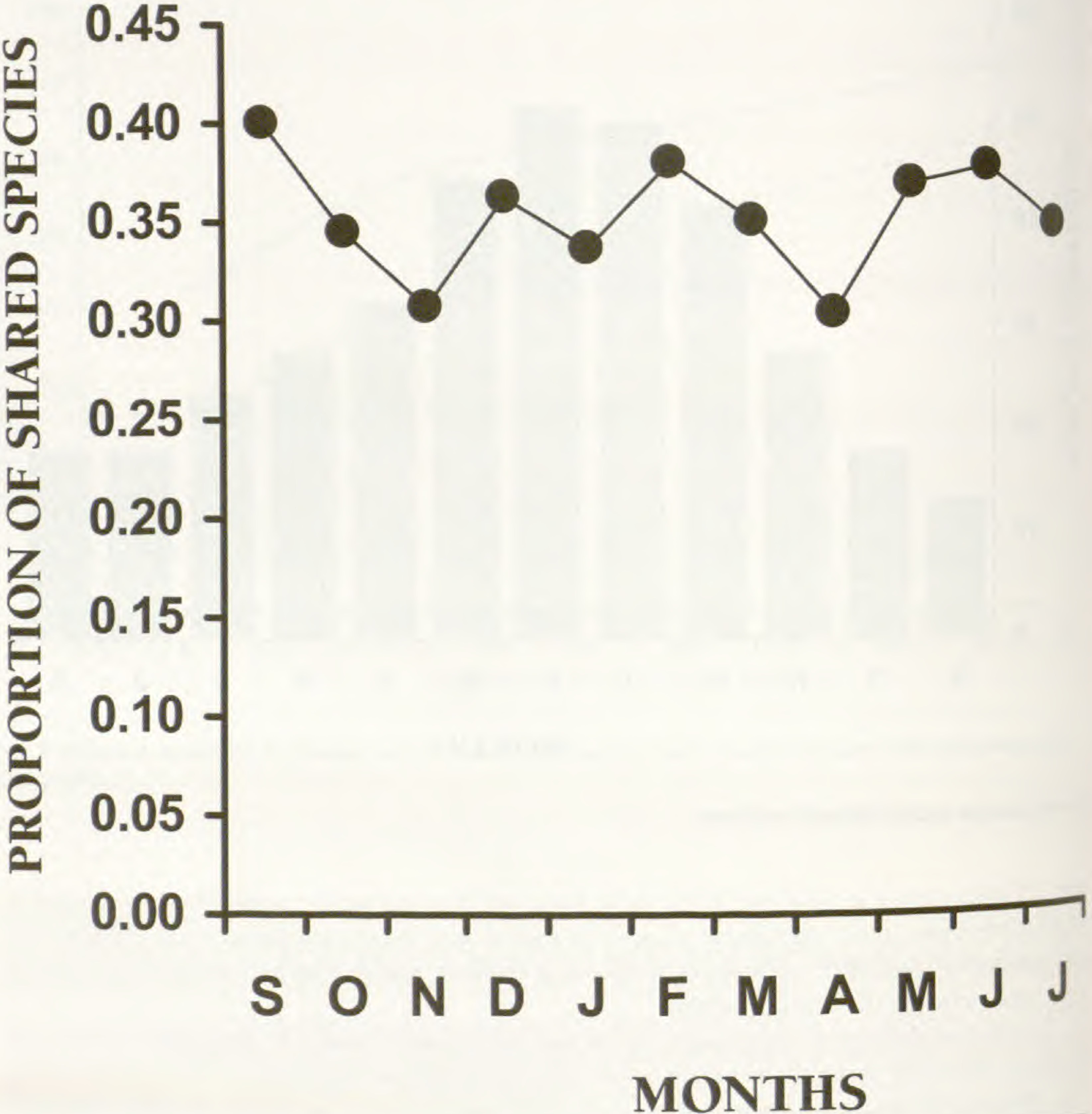

Fig. 6. The proportions of species flowering in one month that were also flowering in the following month.

At present, the species lists from MPHS and the sites of intense study are analogous to the early tree species lists for the Amazonian rainforests. They suggest a small-scaled and as yet unpredictable structure of the orchid community. The only quantitative data on abundance which might imply commonalities in structure are from WCFR, and two aspects of these data do not suggest a simple communality among the sites. First, only four of the seven named abundant species at WCFR, *Epidendrum secundum*, *Maxillaria alpestris*, *Pachyphyllum pectinatum*, and *Pleurothallis acuminata*, were among the 28 species that are common to WCFR, MNP and MPHS. Second, *Pachyphyllum* sp. 1 and *Elleanthus* sp. 1, two of the abundant species at WCFR, were not readily-identifiable or familiar species. If they were similarly abundant at other sites, it may be expected that they would be among the commonly-known and readily-recognized species.

This lack of correspondence of abundant species among sites implies local variation in the abundant orchid species. Large variation in orchid species composition between sites only kilometers apart has been reported by Kuper et al. (2004) where 70 % of the species occurring at one site are not present at the neighboring site, and perhaps such local variation should be expected in a largely epiphytic group where occurrence may be related to the species composition, size, height or age of the host surfaces (Catling & Lefkovitch 1989; Andersohn 2004; Arevalo & Betancur 2006; Trapnell & Hamrick 2006; Burns 2007).

The results of the plot studies also support the possibility that local variation in forest structure and composition may influence orchid species compositions and abundances. Although the total number of orchid individuals appears to be similar across elevation and habitats at WCFR, species richness decreases at higher elevation and within stands of taller cloud forests. Although more forest structure may occur in taller cloud forests, fewer epiphytic species occur in these forests than in shorter stature cloud forests. Taller cloud forests also contain fewer terrestrial species. Although attempts to relate elevation or forest types with distinct orchid floras at WCFR were obfuscated by the large proportion of orchid species which occurred in < 5 plots, the possibility exists that such orchid-forest flora associations may occur and contribute to site-to-site variability in species composition and abundance. Unfortunately none of the studies at MNP, WW or WCFR have collected or reported data on tree species, tree densities, or other aspects of canopy architecture, which might account for variations in orchid diversity, abundance, and distribution.

These results document considerable local variation in the orchid floras of Peruvian cloud forests and suggest that this level of variation may extend to the abundant members of the flora. There is little evidence that the abundant orchid species at WCFR are also abundant, or perhaps even present, at other sites. Until similar analyses of species richness and orchid abundances are available from other sites, the issue of whether there is less site-to-site variation among the abundant members of the orchid flora than that for the flora in general will remain unresolved.

IMPLICATIONS OF THE RESULTS AND EXPERIENCES FOR THE DESIGN OF SIMILAR STUDIES

Varying sampling protocols using plots have been employed or recommended for analyzing orchid floras. Zambrano et al. (2003a) used rectangular 25 m^2 plots at WW, and Zambrano et al. (2003b) used 2 m × 50 m plots at MNP. Gradstein et al. (2003) suggested 20 m × 20 m plots for sampling the < 10-m tall understory of tropical rain forests. The results and experiences of the present study with 5 m × 5 m plots suggest three potentially useful modifications for studies attempting to determine the species composition, species richness, and relative abundance of cloud forest orchids.

First, plots alone are unlikely to be sufficient to determine the species composition of the study area. Although almost all orchid stems with the plots at WCFR flowered and were assigned to morphospecies, the plots contained less than 60% of the species observed in the systematic collection. Zambrano et al. (2003a) also supplement their plot analyses with orchid collections from the area surrounding the plots. The rarefaction analyses also suggest that plots alone are unlikely to be effective in estimating the total number of species present.

Second, the assessments of species composition and abundance in plots must be performed on a monthly basis. There is too little overlap in species flowering in successive months to permit less frequent sampling. Because a single orchid flower may persist for as few as six to eight days (Tremblay et al. 2006), it is possible that even more frequent than monthly sampling may be required.

Third, the plot design and manner of data collection used here can be modified to reduce disturbance and improve efficiency. It was necessary to enter the 5 m × 5 m plots to assess species types and abundances. Despite care, such intrusion may affect the plots composition through time. A design using a rectangular plot with a width of 2 m would allow data collection with little need for intrusion. Given the large disparity between the abundance of rare and common species, enumerating the exact abundance of individuals in a few plots may not be as informative as assessing relative abundance in many plots. A more rapid assessment of relative abundance using an ordinal scale where, for example, 0 indicates no individuals present, 1 indicates < 3 individuals, 2 indicates 3 to 10 individuals and so forth, would be sufficient to establish a gradient of rare to abundant species. A plot composed of a linear arrangement of five 2 × 2 m subplots with the estimated abundance being the median ordinal score of the five subplots could be more rapidly sampled and could provide sufficiently useful data from more plots in less time.

Potentially 150 or more of these plots composed of five 2 × 2 m subplots could be monitored per month with less effort than was required for the 47 plots of this project. The ordinal data from these linear plots can still be used to assess relative abundance and to estimate total species richness using the incidence-based procedures, such as Chao 2, which only require presence and absence data to assess species rareness and predict the number of unsampled species.

Although more efficient sampling procedures could have been employed, this study demonstrates the importance of using long-term combinations of systematic plant collections and quantitative analyses of permanent plots to assess orchid species occurrences and abundance in the Peruvian Andes. It also demonstrates the limited ability to extrapolate these results to broader scales because of the absence of comparable quantitative data from other sites. Even comparisons of species lists among studies are constrained by the incompletely documented taxonomy of some collections. Hopefully, the widespread dissemination of WCFR collections supplemented by extensive information available on the Atrium web site will facilitate future comparisons and allow a more complete assessment of the degree to which orchid communities may possess communalities in composition and abundance similar to those which appear to be occurring for the diverse forest communities of western Amazonia.

APPENDIX S1

A list of orchid species collected at Wayqechas Biological Field Station between September 2005 and August 2006. Species listed as unidentified either remain to be classified as a previously described species or described as a potential new species. Additional information including date of collection, flower description, habit, habitat, digital images is located at http://atrium.andesamazon.org/.

		No. of as yet Unidentified			**No. of as yet Unidentified**
Genera	**Named Species**	**Species**	**Genera**	**Named Species**	**Species**
1 Altensteinia	boliviensis			roncanum	
2 Barbosella	cucullata			saxicola	
3 Baskervilla	machupicchuensis			schlimii	
4 Brachionidium		1		scutella	
5 Cranichis	ciliata	3		secundum	
	engelii			subliberum	
6 Cyclopogon		1		syringothyrsus	
7 Cyrtidiorchis	rhomboglossa			trachysepalum	
8 Cyrtochilum	cimiciferum	1	12 Erythrodes		1
	minax		13 Frondaria	caulescens	
9 Dichaea		1	14 Gomphichis		2
10 Elleanthus	aurantiacus	3	15 Habenaria	corydophora	
	capitatus			dentifera	
	kermesinus			uncatiloba	
	weberbauerianus		16 Hapalorchis	pumilus	
11 Epidendrum	anderssonii	6	17 Hofmeisterella	eumicroscopica	
	blepharistes		18 Lepanthes	dictyota aff.	12
	farinosa			falcata	
	fimbriatum			mesochlora	
	goodspeedianum			ptyxis	
	gracillimum			pumila	
	haenkeanum			tracheia cf.	
	jajense		19 Lepanthopsis		1
	laxicaule		20 Liparis	elegantula	
	macrostachyum aff.			retusa	
	marcapatense		21 Malaxis		4
	mesomicron		22 Masdevallia	antonii	
	renzii			picturata	

		No. of as yet Unidentified			No. of as yet Unidentified
Genera	**Named Species**	**Species**	**Genera**	**Named Species**	**Species**
23 Maxillaria	alpestris aff.	3		mesochlora	
	brevifolia			quadrata	
	brunnea			rubens	
	christobalensis aff.			ruberrina	
	cuzcoensis			vargasii	
	deniseae			vestigipetala aff.	
	dichroma		31 Ponthieva	cornuta	
	divaricata			diptera	
	floribunda			garayana	
	gigantea		32 Prescottia	petiolaris	
	graminifolia			stachyodes	
	haemathodes		33 Prosthechea	farfanii	
	meridensis			fusca	
	mungoschraderi aff.		34 Pterichis		1
	notylioglossa		35 Rusbyella	caespitosa	2
	nubigena		36 Sauroglossum		1
	procurrens		37 Scaphyglottis	punctulata	
	quitensis			summersii	
	rotundilabia		38 Solenidiopsis	galianoi	
	trigona		39 Stelis	antennata	41
	winaywaynaensis			breviracema	
24 Myoxanthes	frutex			grandibracteata	
	gyas			tricardium	
	hirsuticaulis aff.			uninervia	
25 Neodraya	rhodoneura		40 Stellilabium	cuscoense	
26 Odontoglossum	digitatum	1	41 Stenoptera	acuta	
	machupicchuense			ciliaris	
	mystacinum		42 Sudamerlycaste	cobbiana	
	subuligerum			gigantea	
	tetraplasium		43 Telipogon	austroperuvianus	
27 Oncidum	retusum			casadevalliae	
28 Pachyphyllum	breviconnatum	3		javiercastroviejoi	
	crystallinum			mesotropicalis	
	ecallosum			salinasii	
	gracillimum			santiagocastroviejoi	
	hispidulum			tayacajaensis	
	pectinatum			vargasii	
29 Pityphyllum	laricinum				
30 Pleurothallis	acuminata	9	44 Trichoceros	armillatus	
	angustilabia		45 Trichosalpinx	arbuscula	1
	cassidis			chamaelepanthes	
	cordata			intricata	
	coriacardia			teagueii	
	cyathioflora		46 Vargasiella	peruviana	
	imraei		47 Xylobium	elatum	
	lamellaris			squalens	
	melanostele		48 Unknown genus		1

APPENDIX S2

The elevation, habitat type, minimum number of individuals and number of species for 5 m x 5 m plots at the Wayqechas Biological Field Station.

Plot Number	Elevation above Mean Sea Level (m)	Habitat Type	Minimum Number of Individuals per Plot	Number of Species
1	2612	Short Cloud Forest	23	8
2	2609	Short Cloud Forest	48	12
3	2575	Tall Cloud Forest	9	3
4	2557	Tall Cloud Forest	52	15
5	2530	Tall Cloud Forest	107	17
6	2508	Tall Cloud Forest	67	13
7	2496	Tall Cloud Forest	28	11
8	2517	Short Cloud Forest	43	15
9	2501	Grass Areas	30	12
10	2524	Short Cloud Forest	66	22
11	2538	Tall Cloud Forest	19	9
12	2526	Short Cloud Forest	127	25
13	2808	Tall Cloud Forest	5	3
14	2787	Short Cloud Forest	35	5
15	2760	Tall Cloud Forest	62	5
16	2686	Short Cloud Forest	63	15
17	2662	Grass Areas	101	19
18	2666	Short Cloud Forest	68	19
19	2666	Short Cloud Forest	78	19
20	2665	Short Cloud Forest	83	24
21	2661	Short Cloud Forest	32	14
22	2606	Short Cloud Forest	63	20
23	2982	Short Cloud Forest	43	9
24	2993	Short Cloud Forest	102	14
25	2969	Grass Areas	59	6
26	2973	Grass Areas	50	7
27	2966	Grass Areas	21	3
28	2970	Grass Areas	32	3
29	2968	Short Cloud Forest	33	6
30	2946	Short Cloud Forest	16	5
31	2945	Short Cloud Forest	52	10
32	2954	Short Cloud Forest	31	9
33	2917	Tall Cloud Forest	202	3
34	2915	Tall Cloud Forest	11	7
35	2849	Short Cloud Forest	34	8
36	2820	Tall Cloud Forest	11	7
37	2844	Tall Cloud Forest	120	7
38	2839	Tall Cloud Forest	15	8
39	2831	Tall Cloud Forest	17	5
40	2819	Short Cloud Forest	90	17
41	2817	Short Cloud Forest	68	12
42	2802	Grass Areas	82	15
43	2817	Short Cloud Forest	103	15
44	2801	Tall Cloud Forest	12	5
45	2778	Tall Cloud Forest	45	9
46	2845	Tall Cloud Forest	37	6
47	2932	Grass Areas	70	8

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THE FERNS AND LYCOPHYTES OF A MONTANE TROPICAL FOREST IN SOUTHERN BAHIA, BRAZIL

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ABSTRACT

The Serra Bonita Mountain Range is located in southern Bahia State, northeastern Brazil, and occupies an area of approximately 7,500 ha. The Serra Bonita Reserve encompasses the last remnants of old-growth forest from that region, protecting about 2,000 ha of land (at 300 to 1,080 m a.s.l.) in the center of this mountain range. A floristic survey of the ferns and lycophytes of this Reserve was carried out from 2005 to 2009 in areas above 600 m, resulting in the collection of 182 species, distributed among 67 genera and 23 families. Ferns comprised 173 species in 64 genera and 21 families, while the lycophytes comprised nine species in three genera and two families. Approximately 25 percent of these species were recorded for the first time in Bahia State or northeastern Brazil (44 new records). Special mention is given to *Asplenium truncorum* (Aspleniaceae), *Megalastrum indusiatum* (Dryopteridaceae), and *Thelypteris beckeriana* (Thelypteridaceae), which were described for the first time from recent collections in the study area. The Serra Bonita Reserve also harbors the only known population of *Terpsichore asplenifolia* (Polypodiaceae) in Brazil.

RESUMO

A cadeia de montanhas da Serra Bonita localiza-se no sul da Bahia, nordeste do Brasil, e ocupa uma área de aproximadamente 7.500 ha. Com o intuito de proteger os últimos remanescentes de floresta bem preservada da região, a Reserva Serra Bonita abrange cerca de 2.000 ha (entre 300 e 1080 m s.n.m.) na porção central desta serra. Durante os anos de 2005 a 2009 foi realizado o levantamento das samambaias e licófitas desta Reserva. Para tanto, foram feitas coletas periódicas de material botânico, exclusivamente acima dos 600 m de altitude, resultando em 182 espécies, distribuídas em 67 gêneros e 23 famílias. Dentre estas, as samambaias compreenderam 173 espécies, distribuídas em 64 gêneros e 21 famílias, enquanto as licófitas incluíram nove espécies em três gêneros e duas famílias. Aproximadamente 25 por cento destas espécies são citadas pela primeira vez para o Estado da Bahia ou para o Nordeste do Brasil (44 novos registros). Menção especial para *Asplenium truncorum* (Aspleniaceae), *Megalastrum indusiatum* (Dryopteridaceae) e *Thelypteris beckeriana* (Thelypteridaceae), descritas com base em materiais recentemente coletados na área estudada. A Reserva também abriga a única população conhecida de *Terpsichore asplenifolia* (Polypodiaceae) no Brasil.

INTRODUCTION

Bahia is one of the richest states in Brazil in terms of numbers of plant species and contains representative areas of almost all of the phytogeographic domains in the country (Brazão & Araújo 1981). According to Harley and Mayo (1980), two factors that contribute greatly to this species richness are the topography and the extension of the state, which covers an area of approximately 560,000 km^2 (larger than France, with ca. 544,000 km^2). This ample territory likewise contains considerable climatic diversity, principally as one moves from the coast to the continental interior. Humid Atlantic Forests are found in the eastern part of the state, while semi-arid regions (including the "caatinga" [dryland], "cerrado" [savanna], riparian forests, seasonal forests, and "campos rupestres" [open, rocky mountain vegetation]) occupy more than 50% of the state (Giulietti et al. 2006).

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Although this floristic richness has attracted the attention of many visiting botanists starting in the 19th century (for a more detailed account, see Urban, 1906), few collections have been made in the humid forests of southern Bahia.

Remnants of the Atlantic Coastal Forest in southern Bahia are known to be among the most important sites for conservation of biodiversity in the world. Indeed, these forests seem to hold higher levels of species richness and plant endemism than any other part of the Brazilian Atlantic Rain Forest (Mori et al. 1981; Thomas et al. 1998, 2008; Martini et al. 2007). Southern Bahia is also considered one of the most remarkable Pleistocene forest refuge areas, and a center of diversity for several major groups of organisms (Mori et al. 1983; Whitmore & Prance 1987; Gentry 1992).

Most botanists studying this region have directed their efforts towards angiosperms, with only rare studies of ferns and lycophytes, although the plant lists prepared by Mori et al. (1983) and Amorim et al. (2005, 2008) are notable exceptions. Additional recent taxonomic information has also become available concerning specific groups of ferns in Fernandes (2003), Labiak and Prado (2003, 2005a, 2005b, 2005c, 2007), Matos et al. (2009, 2010), Prado (2000), and Sundue and Prado (2005). In addition to species lists of the ferns and lycophytes of southern Bahia State, Paciencia and Prado (2004, 2005a, 2005b) have described some of the ecological aspects of the area.

Considering these survey limitations and the fact that essentially all of the floristic studies undertaken in southern Bahia have focused on the diversity of lowland vegetation, it is clear that the regional flora continues to be insufficiently studied. In an effort to further our floristic knowledge of the Brazilian Atlantic Forest, the present study examined the fern and lycophyte species in a fragment of montane humid forest in southern Bahia.

STUDY SITE

The Serra Bonita Mountain Range occupies an area of approximately 7,500 ha in the municipalities of Camacan and Pau-Brasil, 130 km from the city of Ilhéus and 526 km from the state capital, Salvador (Fig. 1).

The Serra Bonita Private Reserve is located in the central region of this range (15°23'S × 39°33'W) and was founded to help protect regional biodiversity. The reserve occupies an area of approximately 2,000 hectares at elevations that vary from 300 to 1,080 m (Amorim et al. 2009).

Roeder (1975) described the climate of the region as warm and humid, with an average annual rainfall of 1,500–1,800 mm that is well distributed throughout the year. Average annual temperatures vary between 23 and 24°C, the total annual evapotranspiration potential is 1,200–1,300 mm, and the relative humidity reaches 80%. There is no specific information currently available for precipitation and temperature within the study area itself, although there are obvious climatic variations between the highland and lowland areas, where Roeder's earlier collections (1975) were made.

Both the degree of preservation and the physical structure of the vegetation within the reserve vary greatly, with some regions having intact forests while others have forests in different stages of regeneration (areas that were harvested for timber or cleared for agriculture). Additionally, a road leading to a mountaintop transmission tower cuts through part of the Reserve, resulting in the eradication of the original vegetation in that area (Amorim et al. 2009).

Recent research has shown that the few remaining moist forest fragments in the region shelter large numbers of rare species, including two endangered primates: *Cebus xanthosternos* (yellow-breasted capuchin) and *Leontopithecus chrysomelas* (golden-headed lion tamarin) (Vitor O. Becker, pers. comm.). Preliminary floristic studies have identified ca. 700 species of angiosperms (Amorim et al. 2009), with several species new to science, including a very notable bromeliad (Amorim & Leme 2009).

However, despite its remarkable regional biodiversity, the harvesting of native trees for timber continues to be a major contributor to forest destruction in this area.

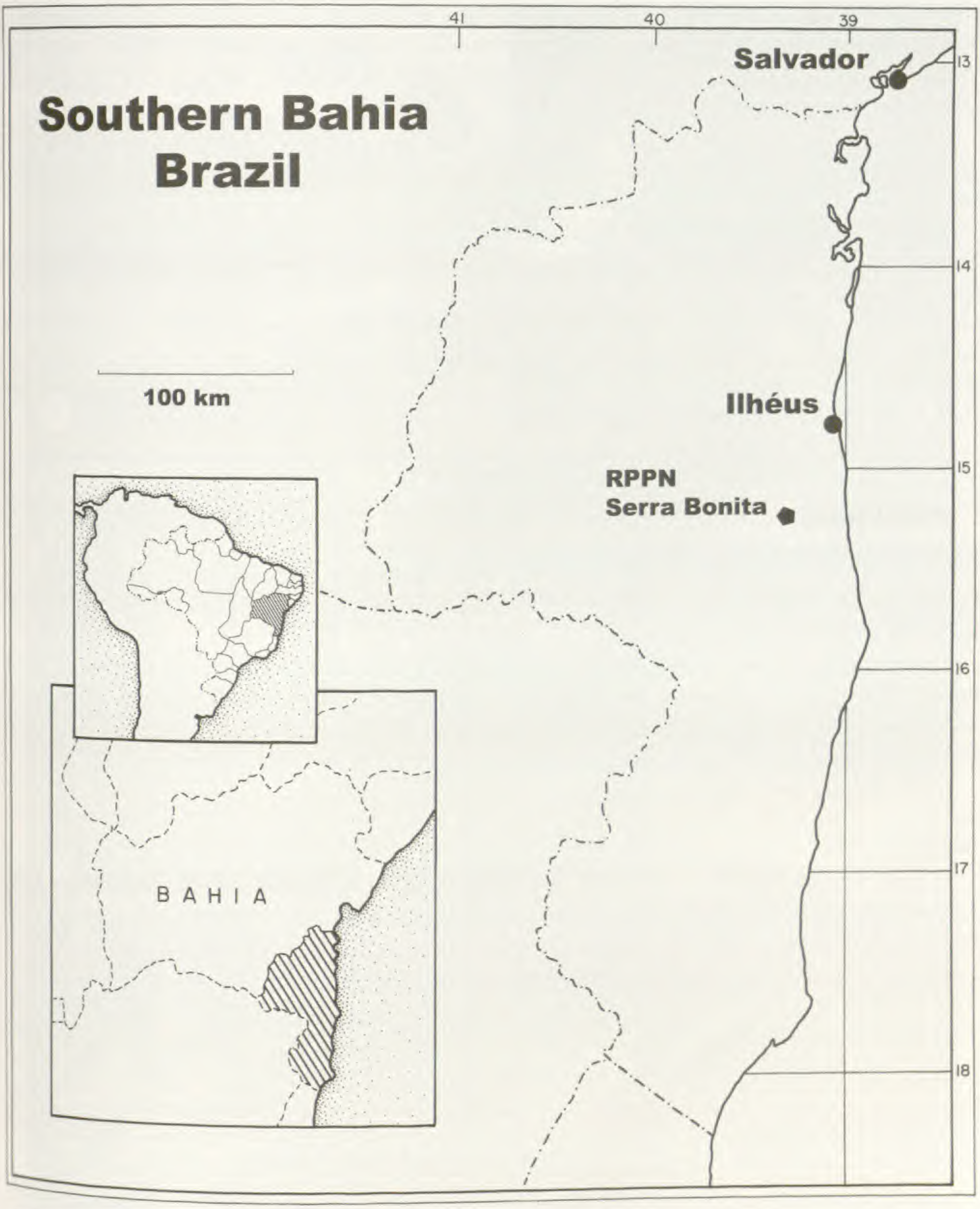
Southern Bahia
Brazil
41
40
39
13
14
15
16
17
18
Salvador
100 km
Ilhéus
RPPN
Serra Bonita
BAHIA

Fig. 1. Serra Bonita Reserve and its location in southern Bahia, Brazil (South America).

METHODS

A floristic survey was carried out in Serra Bonita at elevations from 600 to 1,080 m, from January 2005 to July 2009, during ten collecting expeditions undertaken at intervals of approximately six months.

More than 400 specimens of ferns and lycophytes were collected by the authors during the present study, in addition to occasional collections made by other botanists. Among the herbarium material available for this area are some ferns and lycophytes that were collected by Talmon Soares dos Santos (in 1969, 1971, and 1979), Scott Alan Mori (in 1979), André Maurício Vieira de Carvalho (in 1983), and Wm. Wayt Thomas (in 1994 and 2002). Complete sets of all of these collections are deposited in the CEPEC herbarium, and duplicates have been sent to NY and UPCB.

While duplicates of some collections were sent to specialists of other institutions for identification, the great majority of the plants were identified by the first author using well-documented collections at CEPEC, NY and UPCB (among others) and specific bibliographies.

The ferns and lycophytes are arranged alphabetically in the checklist by family, genus, and then species. The fern families were circumscribed according to the system proposed by Smith et al. (2006). Authors of species names are abbreviated according to Pichi Sermolli (1996). Occasionally, a specimen could be reliably identified only to genus but was clearly distinct from any of the identified material; these specimens were included in the list as "sp." In the present work, the concept of Atlantic Forest was treated in a broader sense (Oliveira-Filho & Fontes 2000), with the result that the areas of distribution of some species extended into the continental interior, sometimes reaching neighboring countries (Argentina and Paraguay).

RESULTS

A total of 182 species in 67 genera and 23 families of ferns and lycophytes from the Serra Bonita Reserve are presented here (Appendix 1). The ferns comprised 173 species in 64 genera and 21 families, while the lycophytes included nine species in three genera and two families. Only three species remained unidentified (*Ctenitis* sp., *Elaphoglossum* sp., and *Thelypteris* sp.), but they are distinctly different from all of the other species in their respective genera.

The most diverse fern families were Polypodiaceae (35), Dryopteridaceae (28), Pteridaceae (19), and Hymenophyllaceae (16). Together, these four families comprise about 57 percent of the species found in Serra Bonita. The most species-rich genera were *Asplenium* (12), followed by *Elaphoglossum* (11), *Thelypteris* (10), and *Diplazium* (9).

Several specimens collected during this study have been identified as new species or are currently being described by specialists, including: *Asplenium truncorum*, *Megalastrum indusiatum*, and *Thelypteris beckeriana* (Fig. 2C–E).

Terpsichore asplenifolia (Fig. 2F) was recorded for the first time in Brazil, and this species shows a disjunct distribution between the Venezuelan-Guyana Shield and the Serra do Mar Mountains in northeastern Brazil (Labiak & Prado 2007). Forty-three additional species were recorded for the first time for Bahia or northeastern Brazil (comprising the states of Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, and Sergipe), representing 24.2% of the total number of species found in the reserve. These new records are indicated with asterisks in the checklist (Appendix 1). In general, these new records represent species characteristic of montane areas of the Atlantic Forest of southeastern Brazil, and are not expected to occur in the other states of northeastern Brazil. *Polypodium dulce*, *Pteris schwackeana*, *Selaginella decomposita*, *S. flexuosa*, and *Serpocaulon levigatum* have been previously reported from other states in northeastern Brazil, but are new records for the Atlantic Rain Forest of southern Bahia.

In terms of habitat preferences, many representatives of the local flora are typically associated with disturbed environments (e.g., roadsides, forest edges, forest regrowth, cabrucas [cocoa plantations under native forests], and other anthropogenic sites), and include: *Adiantum latifolium*, *Asplenium auritum*, *Blechnum brasiliense* (Fig. 3), *B. occidentale*, *Dennstaedtia globulifera*, *Dicranopteris flexuosa*, *Gleichenella pectinata* (Fig. 3), *Hemionitis tomentosa*, *Hypolepis* aff. *repens*, *Lycopodiella cernua*, *Lygodium volubile*, *Osmundastrum cinnamomeum*, *Pityrogramma calomelanos*, *Pleopeltis pleopeltifolia*, *Pteridium arachnoideum*, *Sticherus bifidus*, *S. lanuginosus*, *Thelypteris opposita*, and *T. serrata*.

The great majority of the ferns and lycophytes identified in the present study (more than 70%), however, were characteristic of intact forests or areas in advanced states of regeneration.

In relation to the plant habitats, 49% of the species inventoried were exclusively terrestrial (89 spp.

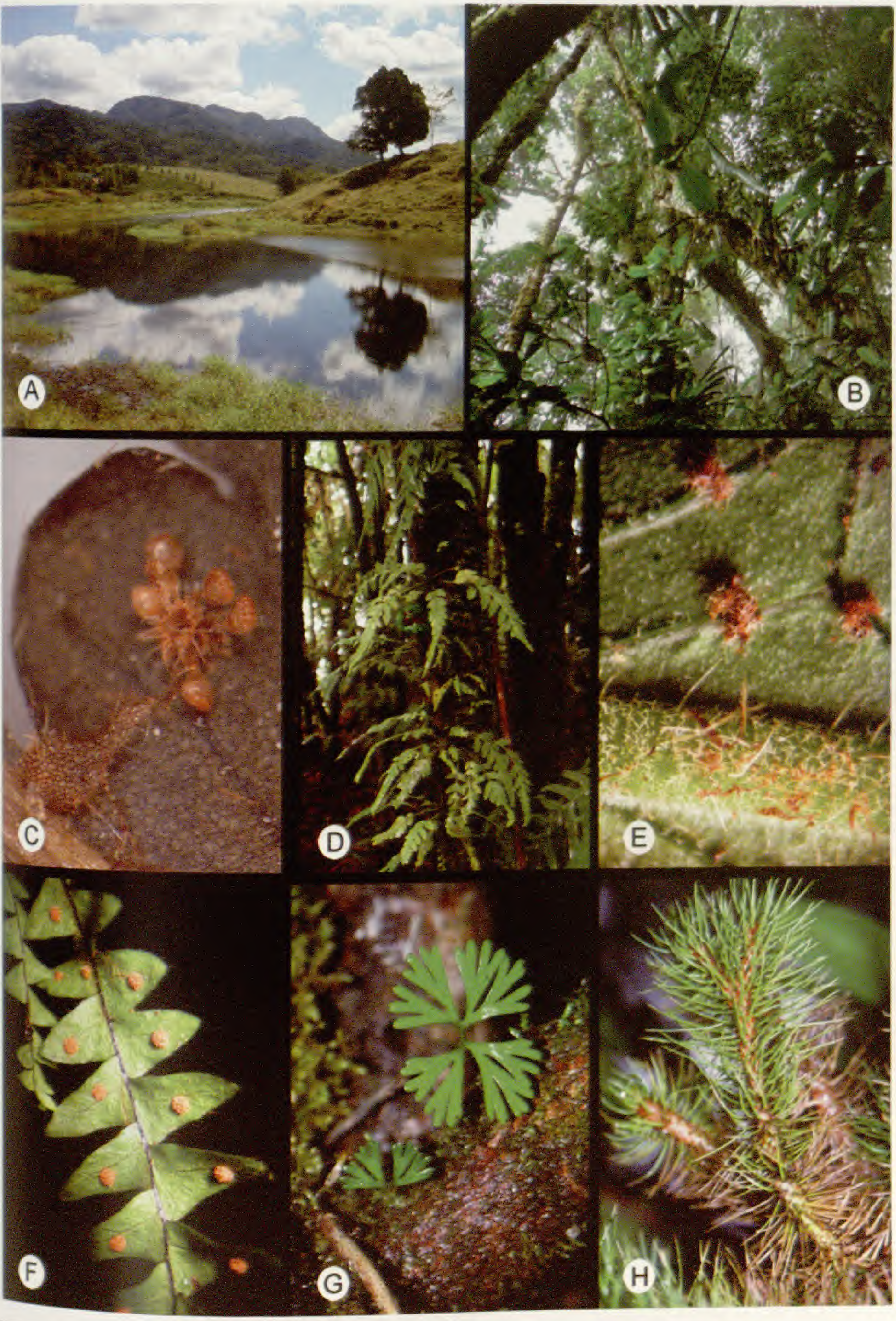

Fig. 2. Vegetation of the Serra Bonita Reserve. **A.** View of the eastern mountainside. **B.** Interior of the forest at the top of the mountain, showing many epiphytes. **C.** *Megalastrum indusiatum*. **D.** *Asplenium truncorum*. **E.** *Thelypteris beckeriana*, described in honor of Dr. Vitor O. Becker, owner of the Serra Bonita Reserve. **F.** *Terpsichore asplenifolia*. **G.** *Elaphoglossum peltatum*. **H.** *Huperzia mandiocana*, a lycophyte. All photos by F.B. Matos.

including herbaceous, arboreal and climbing plants), 32.5% were epiphytes (59 spp.), 5% were rupiculous (9 spp.), and 2% were hemi-epiphytes (4 spp.); another 21 taxa (11.5%) were encountered in more than one type of habitat.

DISCUSSION

Habitat

Ferns are the third most species-rich group of epiphytes in the New World, after orchids and bromeliads (Gentry & Dodson 1987). The last two groups are represented in the Serra Bonita Reserve by 62 and 25 species respectively (Amorim et al. 2009), thus making the ferns the second most diverse group of epiphytic plants in the area (59 spp.).

Several authors (e.g., Moran et al. 2003; Mehltreter 2008) have observed that some epiphytic fern species demonstrate notable specificity in relation to the type of substrate (i.e., phorophytes) on which they can grow. The arboreal ferns of the family Cyatheaceae stand out among the phorophyte supports available in tropical humid forests, as they generally have a dense mass of adventitious roots surrounding their trunks, which can store considerable quantities of water and nutrients due to their high porosity (Mehltreter 2008). In Serra Bonita, five epiphyte species were observed growing exclusively on this type of substrate (notably on *Alsophila setosa*), including *Asplenium truncorum*, *Pecluma truncorum*, *Polyphlebium angustatum*, *Terpsichore asplenifolia*, and *Trichomanes polypodioides*. However, most epiphytic species inventoried did not appear to depend exclusively on these ferns and were collected on a wide variety of angiosperms.

Among the terrestrial species, it is clearly noticeable the preference of many narrowly distributed species to the forest understory, occurring exclusively in well-preserved forest remnants. The high diversity of epiphytic ferns, and the large number of terrestrial species in the forest understory, show the importance of well-preserved environments not only for the richness of species in numerical terms, but also for the maintenance of the narrowly distributed species populations.

Geographical distribution and endemism

According to Tryon (1972), Brazil is one of the principal centers of fern and lycophyte diversity and endemism in the Neotropical region, with about 40% endemism.

The number of species endemic to the Atlantic Rain Forest that were encountered in the Serra Bonita Reserve is quite high (59 species, or 32.5% of the total), especially when compared with other studies undertaken in the Atlantic Rain Forest domain (e.g., Labiak & Prado 1998; Salino et al. 2005; Schwartsburd & Labiak 2007; Amorim et al. 2008).

Similar to the situation of many angiosperms (Amorim et al. 2009), the mountains of southern Bahia appear to constitute the northern limit of occurrence for many endemic ferns and lycophytes in the Atlantic Forest. Some of these species can be considered characteristic of the montane regions of southeastern and southern Brazil (e.g., *Adiantum mynssenae*, *Asplenium scandicinum*, *Cyathea rufa*, *Huperzia flexibilis*, *H. martii*, *Micropolypodium achilleifolium*, *Pleopeltis pleopeltidis*, *Pteris angustata*, *Terpsichore reclinata*, *Thelypteris raddii*, and *Vittaria scabrida*, among others).

Paradoxically, the southern region of Bahia represents the southern limit of distribution of some species endemic to the Atlantic Forest, as they also occur in the "Brejos de altitude" (high elevation dryland forests) of northeastern Brazil. Two examples of this unusual situation among the taxa recorded for the Serra Bonita Reserve are *Cyathea praecincta* and *Megalastrum eugenii*.

Although ferns and lycophytes are usually capable of dispersing over large areas, mountain chains have been found to represent frequent barriers to their migration (Tryon 1986; Moran 1995, 2008). In addition to favoring high levels of endemism, mountains can also influence the taxonomic richness of a given region. Entire families can sometimes be considered typical (but not exclusive to) high elevation regions and have a fundamental role in the floristic characterization of those areas (Moran 1995; Paciencia 2008). According to these authors, the main examples of these families are Cyatheaceae, Dryopteridaceae, Hymenophyllaceae, Lycopodiaceae, and Polypodiaceae. In the same sense, many tropical genera such as *Diplazium* and *Elapho-*

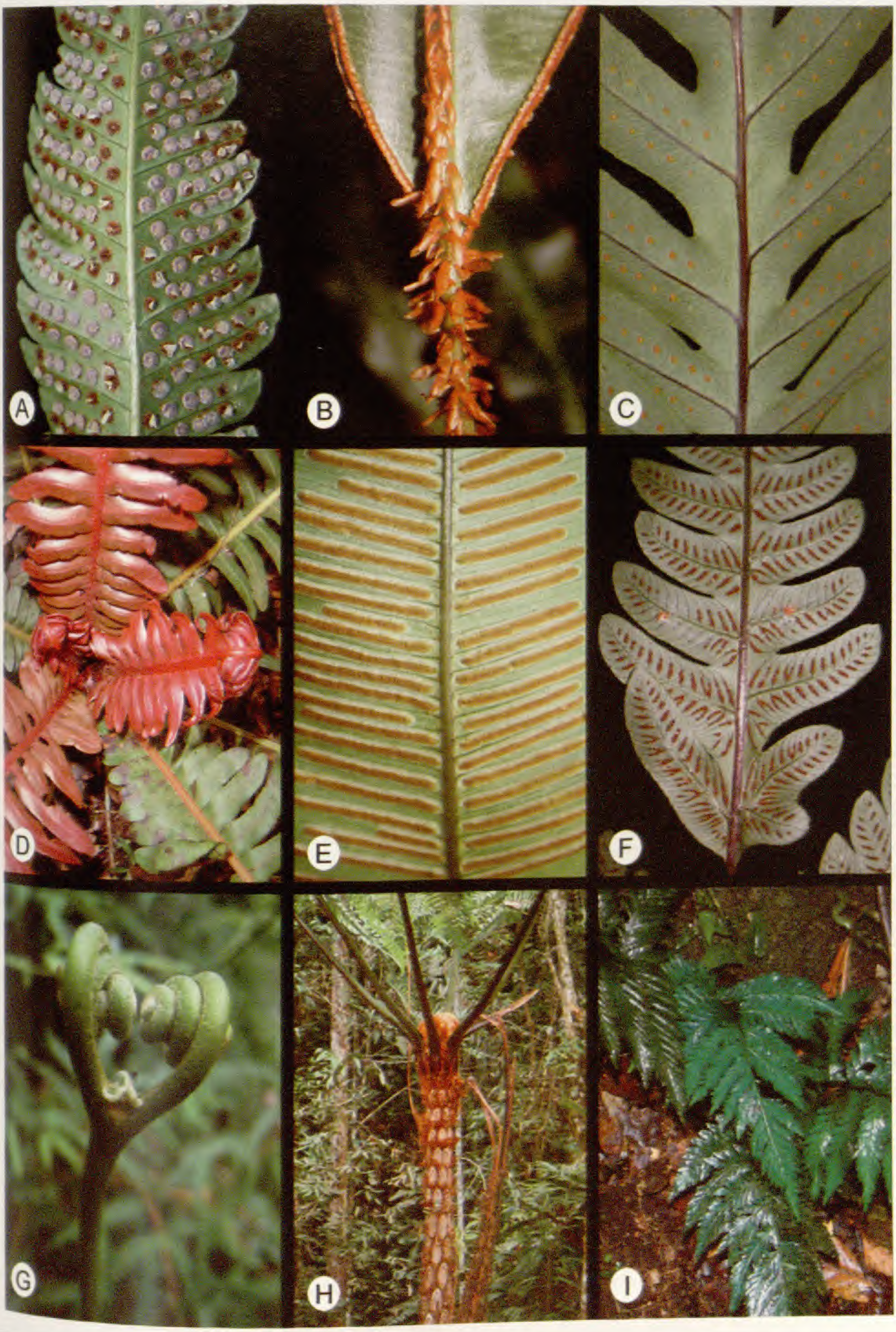

Fig. 3. Some characteristic ferns of the Serra Bonita Reserve. **A.** *Cyclodium heterodon*. **B.** *Elaphoglossum decoratum*. **C.** *Phlebodium pseudoaureum*. **D.** *Blechnum brasiliense*. **E.** *Diplazium lechleri*. **F.** *Thelypteris polypodioides*. **G.** *Gleichenella pectinata*. **H.** *Cyathea delgadii*. **I.** *Trichomanes elegans*. All photos by F.B. Matos.

glossum are predominantly found at high elevations, and it is therefore not a coincidence that they show the greatest species richness in the Serra Bonita Reserve.

It is also important to note the existence of species with disjunct distributions between the Atlantic and Amazon (and/or Andean) forests. According to Tryon (1986), a given fern species can be considered disjunct when the distance between its populations reach about 1,000 km or more, even though there are adequate environments for their occurrence in the intervening regions. *Doryopteris sagittifolia* (Pteridaceae), for example, occurs in the mountains of eastern Brazil but has also been reported in isolated populations in various countries in northern South America (Guyana, French Guyana, Suriname and Venezuela). *Terpsichore asplenifolia* (a species widely distributed from southern Mexico to Bolivia and the Antilles) occurs disjunctly in Brazil, and the Serra Bonita Reserve is the site of the only known population in the country (Labiak & Prado 2007). Also noteworthy are *Elaphoglossum gardnerianum*, *Hymenophyllum caudiculatum* and *Pleopeltis monoides*, Brazilian endemics showing disjunct distributions between the Atlantic and Amazon forests; 58 additional species encountered in our study occur in both southern Bahia and in Amazon forests.

Some Brazilian species have wide geographical distributions throughout many parts of the world (e.g., *Adiantum latifolium*, *Asplenium auritum*, *Hymenophyllum polyanthos*, *Lycopodiella cernua*, and *Pityrogramma calomelanos*), so it is not surprising to encounter them in most Brazilian phytogeographical domains. The number of species shared by both the Atlantic and Amazon forests (a total of 61 species) is still quite notable, however, especially in view of the fact that these two extensive forest formations are separated by a "diagonal of drought"—a corridor of highly seasonal and dry formations (e.g., the "Caatinga" of northeastern Brazil, the "Cerrado" savanna of Central Brazil, and the "Chaco" of Paraguay, Argentina and Bolivia) (Prado & Gibbs 1993) that "isolates" the Atlantic Rain Forest from other rain forests in South America (Andean and Amazon forests).

Although reported by many authors (e.g., Andrade-Lima 1953, 1966, 1969; Bigarella et al. 1975; Mori et al. 1981; Rizzini 1997), the disjunction observed between species of the floras of northern and eastern Brazil must be evaluated with some caution, as the differentiation between long distance dispersal and vicariance in the historical biogeographical patterns of fern distribution requires still more intensive examination (Wolf et al. 2001).

Invasive species

In spite of the relatively recent introduction of *Macrothelypteris torresiana*, *Nephrolepis brownii*, *N. cordifolia*, and *Thelypteris dentata* into the tropical Americas, these species are already found in many areas of South America (Mickel & Smith 2004; Hovenkamp & Miyamoto 2005). These species are primarily associated with ruderal environments in the Serra Bonita Reserve (e.g., along forest edges, disturbed areas, and areas under cultivation) and apparently are not yet seriously competing with the local flora for habitats.

Taxonomic difficulties

The low number of unidentified species encountered in the present study (three) is due, in large part, to the collaboration of many specialists in identifying this material (see Acknowledgments). Identification was especially difficult in very diverse or little-studied genera such as *Ctenitis*, *Elaphoglossum*, and *Thelypteris*, each of which had one species of unknown identity.

Floristic relationships

Preliminary analyses of similarities between the flora of southern Bahia and other diverse localities in tropical America (Matos 2009) indicate that the montane forests of southern Bahia are especially characterized by "southern" elements of the Atlantic Forest. The large number of new records reported here supports this view, as the majority of these species are characteristic of the montane regions of southern Brazil. The same close floristic relationships between the montane forests of southern Bahia and the mountains of southeastern Brazil has likewise been observed for the angiosperms (Amorim et al. 2009). On the other hand, the low elevation forests of southern Bahia appear to be more closely related to the Amazon forests or to northern areas of the Atlantic Forest. More detailed studies are still necessary, however, to better evaluate these relationships

Conservation

One of the greatest modern challenges to mankind is reconciling economic growth (which usually implies increased utilization of natural resources) with global biodiversity conservation, and preservation efforts must be optimized by establishing criteria that guarantee the most favorable possible balance between costs, social needs and the efficient functioning of established conservation areas (Crozier 1997; Crandall et al. 2000).

Among the notable examples of diversity observed in the region, some species are noteworthy by their rarity, ecological importance, or elevated level of endemism:

- *Asplenium truncorum*, *Megalastrum indusiatum*, and *Thelypteris beckeriana* (Fig. 2): these species have only recently been described based on collections made during the present study (Matos et al. 2009, 2010; Moran et al. 2009);
- *Terpsichore asplenifolia* (Fig. 2): despite the fact that this species has wide geographical distribution in many countries in tropical America, the Serra Bonita Reserve holds the only population currently known from Brazil (Labiak & Prado 2007);
- The Cyatheaceae: besides their ecological importance, it is also well known that members of the Cyatheaceae suffer harvesting pressure from human communities in many tropical regions as they are used in craft articles, plant vases, and as a substrate for cultivating epiphytes. For these reasons, all of the species of this family are now included in the CITES listing (2009). This group is represented by eight species in the Serra Bonita Reserve, including the northernmost populations of *Cyathea rufa*.

It should also be noted that the new records for Bahia and northeastern Brazil (marked with asterisks in Appendix 1) represent approximately 25% of the total number of ferns and lycophytes encountered in the Serra Bonita Reserve.

The montane forests of the Serra Bonita Reserve offer ideal environmental conditions for the establishment and growth of ferns and lycophytes, harboring almost all of the taxonomic orders proposed by Smith et al. (2006) (the only exceptions being the Psilotales, Equisetales and the heterosporous ferns [Salviniales], although the last can be found at lower elevations in the region). The conservation importance of the Serra Bonita Reserve therefore lies not just in the number of species, but also in the phylogenetic diversity it preserves.

APPENDIX 1

Checklist of the ferns and lycophytes from the Serra Bonita Reserve, southern Bahia, Brazil. The asterisk before species names denotes the first records for northeastern Brazil or Bahia, whereas a circle refers to species newly described, based on material collected during the present study. Full name of collectors are as follows: **AA** = André M. Amorim, **FF** = Fabrício M. Ferreira, **FM** = Fernando B. Matos, **ML** = Márdel M. Lopes, **PL** = Paulo H. Labiak, and **WT** = Wm. Wayt Thomas. Abbreviation for the habitat of the species: **EP** = Epiphytic, **HE** = Hemi-epiphytic, **RU** = Rupestrial, and **TE** = Terrestrial.

FERNS AND LYCOPHYTES

Anemiaceae

Anemia hirta (L.) Sw.—FM 625, RU/TE
Anemia mandiocana Raddi—FM 638, RU/TE
Anemia phyllitidis (L.) Sw.—FM 1789, TE

Aspleniaceae

**Asplenium angustum* Sw.—FM 1552, EP
Asplenium auriculatum Sw.—FM 306, EP/RU/TE
Asplenium auritum Sw.—FM 1543, RU
**Asplenium cirrhatum* Rich. ex Willd.—FM 1538, TE
Asplenium feei Kunze ex Fée—FM 448, EP
Asplenium kunzeanum Klotzsch ex Rosenst.—PL 3730, TE/RU
Asplenium martianum C. Chr.—FM 1562, EP/TE
Asplenium pteropus Kaulf.—FM 1567, EP
**Asplenium scandicinum* Kaulf.—FM 299, EP
Asplenium serra Langsd. & Fisch.—AA 5435, EP
**Asplenium triquetrum* N. Murak. & R.C.Moran—FM 313, RU
°*Asplenium truncorum* F.B. Matos, Labiak & L. Sylvestre—FM 1537, EP (Fig. 2)

Blechnaceae

Blechnum acutum (Desv.) Mett.—FM 292, HE/TE
Blechnum brasiliense Desv.—FM 614, TE (Fig. 3)
Blechnum occidentale L.—FM 316, TE
**Blechnum organense* Brade—FM 1064, TE
Salpichlaena volubilis (Kaulf.) J. Sm.—FM 1366, TE

Cyatheaceae

Alsophila setosa Kaulf.—FM 447, TE
Alsophila sternbergii (Sternb.) D.S. Conant—FM 1384, TE
Cyathea corcovadensis (Raddi) Domin—FM 1550, TE
Cyathea delgadii Sternb.—FM 1382, TE (Fig. 3)
Cyathea glaziovii (Fée) Domin—FM 636, TE
Cyathea phalerata Mart.—FM 619, TE
Cyathea praecincta (Kunze) Domin—FM 1088, TE
**Cyathea rufa* (Fée) Lellinger—FM 1103, TE

Dennstaedtiaceae

Dennstaedtia cornuta (Kaulf.) Mett.—FM 1563, TE
Dennstaedtia dissecta (Sw.) T. Moore—FM 295, TE
Dennstaedtia globulifera (Poir.) Hieron.—FM 1529, TE
Dennstaedtia obtusifolia (Willd.) T. Moore—FM 1063, TE
Histiopteris incisa (Thunb.) J. Sm.—PL 3715, TE

Hypolepis aff. *repens* (L.) C. Presl—FM 1522, TE
Pteridium arachnoideum (Kaulf.) Maxon—FM 1368, TE

Dryopteridaceae

**Ctenitis aspidioides* (C. Presl) Copel.—FM 1332, TE
Ctenitis distans (Brack.) Ching—FM 1372, TE
Ctenitis submarginalis (Langsd. & Fisch.) Ching—FM 264, TE
Ctenitis sp.—FM 1787, TE
Cyclodium heterodon (Schrad.) T. Moore—FM 1095, TE (Fig. 3)
Cyclodium meniscioides (Willd.) C. Presl—FM 321, TE
Didymochlaena truncatula (Sw.) J.Sm.—FM 1383, TE
Elaphoglossum sp.—FM 1329, EP
**Elaphoglossum decoratum* (Kunze) T. Moore—FM 445, RU (Fig. 3)
**Elaphoglossum gardnerianum* (Kunze ex Fée) T. Moore—JP 446, EP
Elaphoglossum glabellum J. Sm.—FM 607, RU
Elaphoglossum insigne (Fée) Brade—FM 620, EP
Elaphoglossum lingua Brack.—FM 1060, RU
**Elaphoglossum peltatum* (Sw.) Urb.—FM 1584, EP (Fig. 2)
**Elaphoglossum rigidum* (Aubl.) Urb.—FM 1331, EP
**Elaphoglossum strictum* (Raddi) T. Moore—JP 449, EP
**Elaphoglossum vagans* (Mett.) Hieron.—FM 1583, EP
**Elaphoglossum villosum* (Sw.) J. Sm.—FM 1572, EP
Lastreopsis amplissima (C. Presl) Tindale—FM 284, TE
Lomagramma guianensis (Aubl.) Ching—FM 1047, HE
Megalastrum canescens (Kunze ex Mett.) A.R. Sm & R.C. Moran—FM 1079, TE
Megalastrum connexum (Kaulf.) A.R. Sm. & R.C. Moran—FM 439, TE
Megalastrum eugenii (Brade) A.R. Sm. & R.C. Moran—FM 261, TE
°*Megalastrum indusiatum* R.C. Moran, J. Prado & Labiak—FM 1365, TE (Fig. 2)
**Megalastrum umbrinum* (C. Chr.) A.R. Sm. & R.C. Moran—FM 1076, TE
Olfersia cervina (L.) Kunze—FM 1096, RU/TE
**Polybotrya speciosa* Schott—ML 788, HE
Stigmatopteris prionites (Kunze) C. Chr.—FM 1548, TE

Gleicheniaceae

Dicranopteris flexuosa (Schrad.) Underw.—FM 1804, TE
Gleichenella pectinata (Willd.) Ching—FM 652, TE (Fig. 3)
Sticherus bifidus (Willd.) Ching—FM 657, TE
Sticherus lanuginosus (Fée) Nakai—FM 654, TE

Hymenophyllaceae

Abrodictyum rigidum (Sw.) Ebihara & Dubuisson—FM 301, TE
**Didymoglossum angustifrons* Fée—FM 1097, EP
Didymoglossum reptans (Sw.) C. Presl—FM 1784, EP
Hymenophyllum asplenioides (Sw.) Sw.—FM 648, EP
Hymenophyllum caudiculatum Mart.—FM 303, EP
**Hymenophyllum elegans* Spreng.—PL 3711, EP
Hymenophyllum hirsutum (L.) Sw.—FM 646, EP
Hymenophyllum polyanthos (Sw.) Sw.—FM 645, EP
Polyphlebium angustatum (Carmich.) Ebihara & Dubuisson—FM 1068, EP
Polyphlebium diaphanum (Kunth) Ebihara & Dubuisson—FM 650, EP
Polyphlebium hymenophylloides (Bosch) Ebihara & Dubuisson—FM 649, EP
Trichomanes elegans Rich.—FM 1371, TE (Fig. 3)
Trichomanes pilosum Raddi—FM 1337, EP
Trichomanes polypodioides L.—FM 302, EP
Vandenboschia collariata (Bosch) Ebihara & K. Iwats.—FM 304, RU
**Vandenboschia rupestris* (Raddi) Ebihara & K. Iwats.—FM 1555, RU

Lindsaeaceae

Lindsaea lancea (L.) Bedd.—FM 1376, TE
**Lindsaea quadrangularis* Raddi—FM 1551, TE

Lomariopsidaceae

Lomariopsis marginata (Schrad.) Kuhn—FM 1074, HE
Nephrolepis brownii (Desv.) Hovenkamp & Miyam.—FM 610, TE
Nephrolepis cordifolia (L.) C. Presl—FM 1523, TE
Nephrolepis pendula (Raddi) J. Sm.—FM 1588, EP/TE
Nephrolepis rivularis (Vahl) Mett. ex Krug—FM 1589, EP/TE

Lycopodiaceae

Huperzia acerosa (Sw.) Holub—FM 319, EP/RU
**Huperzia flexibilis* (Fée) B. Øllg.—FM 1571, EP
**Huperzia heterocarpon* (Fée) Holub—FM 1581, EP/RU
Huperzia mandiocana (Raddi) Trevis.—FM 1553, EP (Fig. 2)
Huperzia martii (Wawra) Holub—FM 1777, EP
Lycopodiella cernua (L.) Pic. Serm.—FM 653, TE

Lygodiaceae

Lygodium volubile Sw.—FM 265, TE

Marattiaceae

Danaea geniculata Raddi—FM 1335, TE
Eupodium kaulfussii (J. Sm.) J. Sm.—FM 1067, TE

Oleandraceae

Oleandra articulata (Sw.) C. Presl—FM 440, EP

Ophioglossaceae

Ophioglossum palmatum L.—FM 1375, EP

Osmundaceae

Osmundastrum cinnamomeum (L.) C. Presl—PL 3731, TE

Polypodiaceae

**Campyloneurum acrocarpon* Fée—WT 14230, EP
Campyloneurum aff. *angustifolium* (Sw.) Fée—FM 416, EP
**Campyloneurum decurrens* (Raddi) C. Presl—FM 290, RU
**Campyloneurum nitidum* (Kaulf.) C. Presl—FM 273, EP
Cochlidium serrulatum (Sw.) L.E. Bishop—FM 326, EP
Lellingeria suspensa (L.) A.R. Sm. & R.C. Moran—FM 1368, EP
**Melpomene melanosticta* (Kunze) A.R. Sm. & R.C. Moran—AA 6497, EP
Microgramma acatallela Alston—FM 1577, EP
Microgramma geminata (Schrad.) R.M. Tryon & A.F. Tryon—FM 315, EP
Microgramma lycopodioides (L.) Copel.—FM 1374, EP
Microgramma percussa (Cav.) de la Sota—FM 1544, EP
Microgramma tecta (Kaulf.) Alston—FM 327, EP
Microgramma vacciniifolia (Langsd. & Fisch.) Copel.—FM 279, EP

**Micropolypodium achilleifolium* (Kaulf.) Labiak & F.B. Matos—FM 286, EP
Pecluma pilosa (A.M. Evans) M. Kessler & A.R. Sm.—FM 311, EP/RU
Pecluma plumula (Humb. & Bonpl. ex Willd.) M.G. Price—FM 283, EP/RU
Pecluma recurvata (Kaulf.) M. G. Price—FM 1545, EP/RU
Pecluma robusta (Fée) M. Kessler & A.R. Sm.—FM 1381, EP
**Pecluma truncorum* (Lindm.) M. G. Price—FM 1536, EP
Phlebodium pseudoaureum (Cav.) Lellinger—FM 280, EP/RU (Fig. 3)
Pleopeltis astrolepis (Liebm.) E. Fourn.—FM 1525, EP
Pleopeltis macrocarpa (Bory ex Willd.) Kaulf.—FM 1527, EP
Pleopeltis monoides (Weath.) Salino—FM 281, EP/RU
**Pleopeltis pleopeltidis* (Fée) de la Sota—FM 1528, EP
Pleopeltis pleopeltifolia (Raddi) Alston—FM 656, EP
Polypodium chnoophorum Kunze—FM 1526, EP
**Polypodium dulce* Poir.—FM 1093, RU/TE
Serpocaulon catharinae (Langsd. & Fisch.) A.R. Sm.—FM 291, EP
Serpocaulon fraxinifolium (Jacq.) A.R. Sm.—FM 323, EP
**Serpocaulon levigatum* (Cav.) A.R. Sm.—FM 629, EP
Serpocaulon meniscifolium (Langsd. & Fisch.) A.R. Sm.—FM 1059, EP/RU
Serpocaulon triseriale (Sw.) A.R. Sm.—FM 278, EP/RU/TE
**Terpsichore asplenifolia* (L.) A.R. Sm.—FM 1566, EP (Fig. 2)
**Terpsichore reclinata* (Brack.) Labiak—FM 1338, EP
**Terpsichore taxifolia* (L.) A.R. Sm.—FM 307, EP

Pteridaceae

Adiantopsis radiata (L.) Fée—FM 1369, TE
Adiantum abscissum Schrad.—FM 1373, TE
Adiantum dolosum Kunze—FM 1560, TE
Adiantum latifolium Lam.—FM 1388, TE
**Adiantum mynssenae* J. Prado—FM 1786, TE
Adiantum terminatum Kunze ex Miq.—FM 1389, TE
Doryopteris collina (Raddi) J. Sm.—FM 269, RU
**Doryopteris rediviva* Fée—FF 1294, TE
Doryopteris sagittifolia (Raddi) J. Sm.—WT 13030, RU
Hemionitis tomentosa (Lam.) Raddi—FM 270, RU/TE
Pityrogramma calomelanos (L.) Link—FM 275, TE
Polytaenium lineatum (Sw.) J. Sm.—FM 263, EP
**Pteris angustata* (Fée) C.V. Morton—FM 637, TE
Pteris decurrens C. Presl—FM 1541, TE
Pteris deflexa Link.—FM 660, TE
Pteris denticulata Sw.—FM 1387, TE
**Pteris schwackeana* H. Christ—FM 1091, TE
Pteris splendens Kaulf.—FM 1539, TE
**Vittaria scabrida* Klotzsch ex Fée—FM 632, EP

Saccolomataceae

Saccoloma inaequale (Kunze) Mett.—FM 1070, TE

Selaginellaceae

**Selaginella decomposita* Spring—FM 1069, TE
**Selaginella flexuosa* Spring—FM 310, EP/RU/TE
Selaginella muscosa Spring—FM 1586, TE

Tectariaceae

Tectaria incisa Cav.—FM 267, TE
Triplophyllum hirsutum (Holttum) J. Prado & R.C. Moran—FM 1549, TE

Thelypteridaceae

Macrothelypteris torresiana (Gaudich.) Ching—FM 274, TE
Thelypteris sp.—FM 1559, TE
°*Thelypteris beckeriana* F.B. Matos, A.R. Sm. & Labiak—FM 1558, TE (Fig. 2)
Thelypteris dentata (Forssk.) E.P. St. John—FM 1531, TE
**Thelypteris leprieurii* (Hook.) R.M. Tryon—FM 1532, TE
Thelypteris macrophylla (Kunze) C.V. Morton—FM 1561, TE
**Thelypteris opposita* (Vahl) Ching—FM 1524, TE
Thelypteris polypodioides (Raddi) C.F. Reed—FM 1380, TE (Fig. 3)
**Thelypteris raddii* (Rosenst.) Ponce—FM 288, TE
Thelypteris serrata (Cav.) Alston—FM 612, TE
Thelypteris vivipara (Raddi) C.F. Reed—FM 1781, TE

Woodsiaceae

Diplazium ambiguum Raddi—FM 658, TE
Diplazium asplenioides (Kunze) C. Presl—FM 296, TE
Diplazium celtidifolium Kunze—FM 1077, TE
Diplazium cristatum (Desr.) Alston—FM 1554, TE
Diplazium lechleri (Mett.) T. Moore—FM 622, TE (Fig. 3)
Diplazium leptocarpon Fée—FM 1081, TE
Diplazium lindbergii (Mett.) Christ—FM 1083, TE
Diplazium mutilum Kunze—FM 436, TE
Diplazium plantaginifolium (L.) Urb.—FM 1385, TE

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do Paraná, which includes illustrations, comments, and keys for the identification of the species (available online at: http://dspace.c3sl.ufpr.br/dspace/handle/1884/19094).

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CAREX OKLAHOMENSIS (CYPERACEAE) NEW TO ALABAMA, GEORGIA, AND LOUISIANA, AND ADDITIONAL RECORDS FOR MISSISSIPPI

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ABSTRACT

Carex oklahomensis is reported new for Alabama, Georgia, and Louisiana, and new records are presented for Mississippi.

RESUMEN

Se cita *Carex oklahomensis* como nuevo para Alabama, Georgia, y Louisiana, y se presentan nuevas citas para Mississippi.

Carex oklahomensis Mackenzie is known from seasonally saturated or inundated soils of open alluvial bottomlands, marshes, right-of-ways, and wet meadows in Arkansas, Delaware, Kansas, Illinois, Indiana, Kentucky, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, Tennessee, Texas, and Virginia (Mackenzie 1931; Steyermark 1963; Bryson et al. 1992; Bryson et al. 1994; Jones and Reznicek 1995; Bryson et al. 1996; Standley 2002). Recent records from northern and eastern states indicate *C. oklahomensis* may be increasing its range (Standley 2002), and human disturbance and other activities seem to be the primary factors in its dispersal (Bryson & Carter 2008). Previously, *C. oklahomensis* populations in Mississippi and Tennessee were associated with highway and airport runway construction and the use of contaminated hay and seeds for erosion prevention and grass maintenance (Bryson et al. 1992; Bryson et al. 1994; Bryson et al. 1996). Some populations of *C. oklahomensis* have persisted for several years and then disappeared following drought or herbicide usage along highway right-of-ways (Bryson 2007), and others have persisted for longer periods (Bryson, pers. obs.).

Herein, we report the first records of *C. oklahomensis* from Alabama, Georgia, and Louisiana and new county records for Mississippi. It is highly likely that *C. oklahomensis* was introduced during highway and reservoir construction or maintenance in contaminated hay, grass seeds, or machinery at these sites, and it is likely that *C. oklahomensis* will continue to disperse in contaminated hay and grass seeds or on construction, maintenance, and mowing equipment. Presently it does not seem to pose a major weed threat.

Voucher specimens: **ALABAMA. Madison Co.:** Meridianville, W of Hwy US 231/431 just N of Beaverdam Creek, 34°50.376'N, 086°34.310'W, open area around lake in front of North Hills Church (PCA) and Westminster Christian Academy, 12 Jun 2006, *Bryson 21602 & Bryson* (JSU, NY, SWSL, VDB, VSC, herb. Bryson); 17 May 2007, *Bryson 22248* (SWSL, VDB, herb. Bryson). **GEORGIA. Whitfield Co.:** S side of Hwy US 76/SR 52, 0.6 mi E jct. with SR 286 to Dawnville, 2.0 mi E jct. with north Dalton by-pass on E-edge of Dalton, 34.78293°N, 84.87904°W, 17 May 2009, *Rothrock 4829* (GA, MICH, MOR, VSC, SWSL, herb. Bryson). **LOUISIANA. Ouachita Par.:** E of Hwy 165 N of Monroe, 16 May 1997, *Thomas 154042* (herb. Bryson; verified by Bryson, 1997). **MISSISSIPPI. Benton Co.:** Hickory Flat, SW jct. of Hwy US 78 and US 178; just W of ramp onto Hwy US 78 from Hwy 178, 34°37.085'N, 089°12.258'W, *Bryson 23235* (NY, VDB, VSC, SWSL, herb. Bryson). **Marshall Co.:** Potts Camp, W of Bypass Street, just N of Hwy US 178, between Hwy US 78 and US 178, 34°39.175'N, 089°18.592'W, 2 Jun 2009, *Bryson 23221* (NY, VSC, SWSL, herb. Bryson). **Montgomery Co.:** ca. 3.5 air mi E of Winona, S of Hwy US 82, 33°28.662'N, 089°40.015'W, 12 Jun 2009, *Bryson 23243 & Bryson* (NY, SWSL, herb. Bryson).

In Alabama, *C. oklahomensis* grew around the edges of a small man-made lake on a dark red clay soil with few intermixed rocks just above the water-line. At this site, *C. oklahomensis* was associated with *Carex annectens* Bicknell, *C. longii* Mackenzie, *C. lurida* Wahlenberg, *C. triangularis* Boeckeler, *C. tribuloides* Wahlenberg, *C. vulpinoidea* Michaux, *Juncus* sp., and a number of Poaceae. Small populations of two to 20 clumps were dis-

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persed around the edge of the lake in open areas. Although the area is mowed periodically, *C. oklahomensis* plants were observed again in May, 2009 (Bryson, pers. obs.). The Georgia population had over 50 plants of *C. oklahomensis* in a wet pasture/shallow marsh that receives road verge runoff. Associated species included *Agrimonia* sp., *Carex annectens*, *C. aureolensis* Steudel, *C. leavenworthii* Dewey, *C. lupulina* Willdenow, *Eleocharis obtusa* (Willdenow) Schultes, *E. palustris* (L.) Roemer & Schultes, *Lolium pratense* (Hudson) S. J. Darbyshire (*Festuca elatior* L.), *Juncus* spp. including *J. effusus* L., *Ludwigia palustris* (L.) Elliott, and *Ranunculus sardous* Crantz. In Louisiana, *C. oklahomensis* grew in a subdivision to the east of a major highway. Volunteer plants of *C. oklahomensis* were discovered in an unplanted wildflower area (Thomas, pers. comm.). At the sites in Mississippi, *C. oklahomensis* grew in wet ditches along the highway right-of-ways on wet silt or clay soils. Common associates in Mississippi were *Carex annectens*, *C. aureolensis*, *C. longii*, *C. lurida*, *C. vulpinoidea*, *Eleocharis obtusa*, *Juncus* spp., and various Poaceae species. The Mississippi populations of *C. oklahomensis* ranged from fewer than 50 plants at the Montgomery County site to several hundred plants at the Marshall County site. Lack of extensive seasonally wet roadside ditches at each of the Mississippi sites may be a limiting factor for additional dispersal, unless mowing equipment transports achenes to suitable habitats several hundred meters from the observed populations.

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PLANTS NEW TO FLORIDA

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ABSTRACT

Thirty four taxa are reported as new to Florida, of which 26 are here reported for the first time as occurring in the continental United States. Of the total, 33 are non-native to Florida. Of these 33, 25 are ornamentals escaped from cultivation, several of which have the potential to become invasive.

RESUMEN

Se citan treinta y cuatro nuevos taxa para Florida, de los que 26 se citan aquí por primera vez para los Estados Unidos continentales. Del total, 33 son exóticas para Florida. De estas 33, 25 son ornamentales escapadas de cultivo, varias de las cuales son potencialmente invasoras.

Work toward a third edition of the *Guide to the Vascular Plants of Florida* to be published in 2010 revealed that in the six years since the publication of the second edition (Wunderlin & Hansen 2003), over 100 species are new to the state. Of these, about 75% are non-native to Florida. About 70% of these have been previously reported for Florida in a variety of publications (e.g., Abbott & Carlsward 2004; Anderson 2007; Bradley 2006; Darst & Gholson 2004; Davis et al. 2006; Kunzer et al. 2009), *Flora of North America* (2003–2009), and several recent taxonomic revisions. Although cited in the online *Atlas of Florida Vascular Plants* (Wunderlin & Hansen 2009), this paper documents the first report of 34 taxa as occurring in Florida. Twenty-six of these taxa are the first reports for the continental United States. Of the total, 33 taxa are non-native and 25 of the non-native species are considered to be escaped from cultivation. A recent paper by Pemberton and Liu (2009) demonstrates that horticultural introductions have been an important source of non-native plants naturalizing (reproducing outside of cultivation) in the state, a trend that will clearly continue. Over half of the species reported here were found in the two most populous counties in Florida (Miami-Dade Co.–13 spp. and Broward Co.–6 spp.). It is likely that some taxa reported here for first time may be listed as invasive exotics in the Florida Exotic Pest Plant Council (FLEPPC) list (2009) in the future.

Araucaria heterophylla (Salisb.) Franco (Araucariaceae). This species, endemic to Norfolk Island in the South Pacific, is cultivated in tropical and subtropical areas of the Old and New World for its wood and as an ornamental, and occasionally becomes naturalized. It is commonly cultivated as an ornamental in central and southern Florida. This is the first report of it naturalizing in the continental United States.

Voucher specimens. **Broward Co.:** Pine Island Ridge Natural Area, 1 mi N of Orange Drive on Golden Shoe Road, ca. 1 mi N of Cooper City, T50S, R41E, Sec. 20, several young plants escaping well away from any possible parent tree, 17 May 2007, *Howell 1002* (USF). **Monroe Co.:** Big Pine Key, Monroe County owned (unnamed) preserve, 100 m E of the intersection of Fern Avenue and Guava Lane, ca. 27 air mi NE of downtown Key West, single tree 5 ft. tall, soil at base of plant does not indicate cultivation, pine rockland, plants within 1 m

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of collection include *Conocarpus erectus*, *Myrica cerifera*, *Mosiera longipes*, *Coccothrinax argentata*, *Chiococca alba*, *Cassytha filiformis*, and *Metopium toxiferum*, 16 May 2007, *Woodmansee 1988* (USF).

Ardisia solanacea Roxb. (Myrsinaceae). A native of Asia, this species is cultivated as an ornamental in tropical areas of the Old and New World where it often becomes naturalized. This is the first report of it naturalizing in the continental United States.

Voucher specimen. **Hillsborough Co.:** Seffner, 309 Smokey Mountain Road, many plants spontaneous, possibly escaping from a nearby nursery, 6 Jun 2007, *York s.n.* (USF).

Artemisia ludoviciana Nutt. (Asteraceae). Native to midwestern and western North America, Mexico, and Central America, it is cultivated worldwide primarily as an ornamental but sometimes for medicinal use. It is occasionally naturalized in the eastern United States and Canada.

Voucher specimen. **Escambia Co.:** near Pensacola, E side of Pace Blvd., S of intersection with Lee Street, escaped from cultivation, edge of weedy lot, with *Bidens alba*, 27 Nov 2003, *Burkhalter 19755* (USF).

Butia capitata (Mart.) Becc. (Arecaceae). A native of Brazil, Argentina, and Uruguay, it is commonly cultivated in the southeast coastal plain from North Carolina to Florida and west through the Gulf coastal states as an ornamental. It is reported from North and South Carolina and Florida (USDA, NRCS 2009), all of which we could not verify by voucher specimens. This report confirms its occurrence as naturalized in Florida and perhaps also from the continental United States.

Voucher specimen. **Hernando Co.:** near SW end of Chinsegut Wildlife and Environmental Area, ca. 6 mi N of Brooksville, T21S, R19E, Sec. 36, NW¼ of SE¼, escaping into disturbed sandhill, 20 Jun 2005, *vanHoek & Petty 2176* (USF).

Celastrus paniculatus Willd. (Celastraceae). Native to temperate and tropical Asia and the Pacific Islands, this species is widely cultivated as an ornamental as well as for the medicinal value of its seed oil. It is occasionally spontaneous in the Old World. This is the first report of its naturalization in the continental United States.

Voucher specimens. **Miami-Dade Co.:** Matheson Hammock Park, ca. 50 m SW of the nature trail parking lot, 25.67934°N, 80.27512°W, several vines clambering along ground and climbing trees into the canopy, 20 May 2003, *Possley et al. 53* (FTG); 12 Jun 2003, *Possley & Rosenberg 54* (FTG).

Cinnamomum verum J. Presl (Lauraceae). Native to tropical Asia and widely cultivated in the Old and New World tropics as a source of the spice cinnamon and also as an ornamental, this species is naturalized in tropical Asia and many islands in the western Indian Ocean, including Mayotte, Mauritius, and the Seychelles, and the West Indies. It is reported here for the first time as naturalized in the continental United States.

Voucher specimens. **St. Lucie Co.:** ca. 1.3 mi NNW of Cloud Reservoir, ca. 4 mi NNE of the Minute Maid Road bridge over the Florida Turnpike, and 1.2 mi S of the Indian River County line, T34S, R28E, Sec. 8, 27°32'33"N, 80°33'16"W, rare small tree in a drained cabbage palm [*Sabal palmetto*] hammock, 24 Aug 2006, *Mejeur & Park s.n.* (USF); 11 acre remnant cabbage palm hammock within ca. 6,000 acres of citrus known as Cloud Grove, small trees reproducing and spreading, T34S, R38E, Sec. 8, 12 Mar 2007, *Peterman s.n.* (USF).

Conyza laevigata (Rich.) Pruski (Asteraceae). Native to Mexico, Central America, South America, and the West Indies, it is here reported for the first time as naturalized in the continental United States.

Voucher specimens. **Miami-Dade Co.:** tree farm at SE corner of SW 248 St. & 107 Ave., 25°32'13.5"N, 80°21'13.5"W, only one plant seen, 18 Feb 2002, *Bradley 2161* (FTG); Dade County Nursery, 22200 SW 137 Ave., frequent weed in tree farm, 25°33'30"N, 80°24'54"W, 5 Apr 2002, *Bradley 2327* (USF); private nursery at 22601 SW 152 Ave., next to offices of The Institute for Regional Conservation, 25.55616°N, 80.43706°W, one plant seen recruiting in a pot, 5 Apr 2002, *Bradley 2333* (FTG).

Cordia curassavica (Jacq.) Roem. & Schult. (Boraginaceae). Native to Mexico, Central America, South America, and the West Indies, it is introduced into the Old World where it has become an aggressive weed in Malaysia, the Pacific Islands, and Australia. It is here reported for the first time as naturalized in the continental United States.

Voucher specimen. **Broward Co.:** Markham Park, N of FL 84, just W of Sunrise, T49S, R40E, Sec. 33/34, 24 Jun 2005, *Howell 871* (USF).

Curculigo capitulata (Lour.) Kuntze (Hypoxidaceae). Native to Asia and Australasia, it is commonly cultivated as an ornamental in temperate and tropical areas of the Old and New World where it sometimes becomes naturalized. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Martin Co.:** preserve in floodplain adjacent to Roebuck Creek, just W of the Florida Turnpike and N of FL 76, SW of Stuart, T39S, R41E, Sec. 6, 7 Apr 2006, *Nicholas s.n.* (USF).

Cydista aequinoctialis (L.) Miers (Bignoniaceae). Native to Mexico, Central America, and South America, it is sometimes cultivated as an ornamental outside its natural range. This is the first report of its naturalization in the continental United States.

Voucher specimen. **Broward Co.:** Davie, along the W side of Davie Road between SW 49 St. & SW 56 St., escaping high into *Casuarina* and *Schinus* here along a 1 km stretch, 15 Dec 2003, *Guertin 6967* (USF).

Cyperus unioloides R. Br. (Cyperaceae). Native to the Old and New World tropics, it is known from the United States only from a single report from California (Abrams 1923; specimen not located) and now Florida, where it apparently is a recent introduction.

Voucher specimens. **Monroe Co.:** Big Cypress National Preserve, wetland with some minor disturbance from off-road vehicles, S edge of Loop Road, just W of Pinecrest, ca. 4.95 air mi W of Miami-Dade Co. line, ca. 5.44 driving mi W of Miami-Dade Co. line, 25.7464°N, 80.9533°W, 19 Aug 2004, *Bradley & Woodmansee 2584* (FTG). **Miami-Dade Co.:** Everglades National Park, Hole in the Donut, in mitigation site, formerly dominated by *Schinus terebinthifolia* that was scraped early 2003, UTM (NAD83) Easting 529745, Northing 2806431, ca. 1.7 km S of Research Road, ca. 8.3 km W of Old Ingram Highway, ca. 9.5 km WSW of Paradise Key Visitor's Center, 5.5 km SW of lake at Long Pine Key campground, elev. 0.41 m, 24 Sep 2003, *O'Hare s.n.* (FTG).

Dieffenbachia seguine (Jacq.) Schott (Araceae). Native to Mexico, Central America, South America, and the West Indies, it is commonly cultivated as an ornamental in both the Old and New World as a container plant or out of doors in tropical areas where it sometimes escapes. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Palm Beach Co.:** edge of wetland slough adjacent to Northfork Drive, at the corner of Cypress Cove subdivision, Jupiter, one plant found at the water/slope interface and others in ca. 10 in. of water, T40S, R42E, Sec. 27, 28 Jun 2005, *Miller s.n.* (USF).

Dimocarpus longan Lour. (Sapindaceae). Native to Asia, it is often cultivated in the Old and New World tropics for its edible fruit and as an ornamental, and is occasionally naturalized. It was introduced into southern Florida in the late 1800's for commercial production. This is the first report of the species naturalized in the continental United States.

Voucher specimen. **Palm Beach Co.:** Loxahatchee River Corridor, ca. 0.3 mi N of Indian Town Road, ca. 0.9 mi W of Florida Turnpike, naturalized around abandoned home site at edge of swamp along Loxahatchee River, many seedlings spreading away from parent tree, 26°56.443N, 80°10.284W, 7 Jun 1997, *Bradley & Woodmansee 58* (FTG).

Drynaria quercifolia (L.) J. Sm. (Polypodiaceae). Native to tropical Asia, Australasia, Australia, and the Pacific Islands, this species is frequently cultivated in the Old and New World tropics as an ornamental. It has been cultivated in a greenhouse at Florida International University and has become well established outside the greenhouse on 13 mature *Phoenix dactylifera* trunks. Plants are common on most of these trees from ground level to the canopy (ca. 10 m), with multiple age classes present, from juveniles to reproductive adults. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Miami-Dade Co.:** Florida International University, SW of intersection of SW 8 St. & 112 Ave., common on *Phoenix dactylifera* trunks surrounding the Wertheim Conservatory, 25.75357°N, 80.373171°W, 19 Jul 2009, *Bradley 2680* (FTG, USF).

Eriochloa acuminata (J. Presl) Kunth (Poaceae). Native to the southwestern United States and Mexico, it is sometimes established outside this region. This is the first report of it naturalized in Florida.

Voucher specimen. **Indian River Co.:** 2 mi N of Gifford, ca. 4 mi N of Vero Beach, cleared area (secondary growth) adjacent to a salt marsh, T32S, R39E, Sec. 14, 9 Jun 1995, *Kessler s.n.* (USF).

Eucalyptus camaldulensis Dehnh. subsp. **acuta** Brooker & M.W. McDonald. (Myrtaceae). *Eucalyptus camaldulensis* has one of the widest natural distributions of any Australian tree species and is one of the most widely cultivated eucalypts in arid temperate and tropical regions of the world (McDonald et al. 2009). Widely cultivated in the United States, sometimes as an ornamental, it has naturalized in California (USDA, NRCS, 2009) and is here documented as naturalized in Florida. Previously treated as a single species or as a northern and southern Australian subspecies by various workers, but a recent taxonomic revision (McDonald et al. 2009) recognizes seven subspecies. Our specimens were determined Tony Bean (BRI) as subsp. *acuta*, which is native to Queensland, Australia.

Voucher specimen. **Charlotte Co.:** Prairie/Shell Creek Conservation Lands, ca. 7 km NE of junction I-75 & US 17, ca. 12 km NE of Punta Gorda, T40S, R23E, Sec. 13, NW¼ of SE¼, scrubby to mesic flatwoods, recently burned, 28 Sep 2009, *Franck 1502* (USF).

Grewia asiatica L. (Malvaceae). Native to tropical Asia, it is cultivated for its fruit and as an ornamental in the Old and New World tropics. It has naturalized in Australia, the Philippines, and the Reunion Islands. First introduced to the United States by David Fairchild, it is cultivated at only a few localities. It is grown at the Tropical Research and Education Center in the Redlands area of Miami-Dade County and has been found naturalized in a county preserve and on private property 0.25 miles south of there in slightly disturbed pine rockland and other disturbed areas. This is the first report of it naturalized in the continental United States. We have also received a report that it is spreading at the Kampong, National Tropical Botanical Garden in Coconut Grove, Florida where it was also cultivated.

Voucher specimen. **Miami-Dade Co.:** West Biscayne Pineland, between SW 190 St. & 192 Ave., just S of theoretical 284 St., in disturbed pine rockland at N end of property, frequent in this and adjacent private property, 25.50238°N, 80.500936°W, 24 Jun 2009, *Bradley 2676* (FTG, USF).

Houttuynia cordata Thunb. (Saururaceae). Native to temperate and tropical Asia, it is cultivated worldwide as an ornamental, and also for human food and medicine. It has become naturalized in wetland habitats in New Zealand and North America (Louisiana) where it is considered invasive. It is also reported from Pennsylvania (USDA, NRCS 2009).

Voucher specimens. **Hillsborough Co.:** Fishhawk Ranch, ca. 2 mi NE of Boyette, escaping from cultivation and spreading, T30S, R21E, Sec. 34, 28 Jul 2003, *Dickman s.n.* (USF); Fishhawk Ranch, ca. 2 mi NE of Boyette, escaping from cultivation and spreading, T30S, R21E, Sec. 34, 18 Aug 2004, *Dickman s.n.* (USF).

Lumnitzera racemosa Willd. (Combretaceae). This mangrove species is native from Asia to Australia, west to Madagascar and to east Africa. Originally cultivated in Fairchild Tropical Botanic Garden in plots 159, 198, and 180 in 1966, it naturalized there and in adjacent Matheson Hammock. FTG began removal of the species from its property in February 2009. This is the first report of it naturalized in the continental United States.

Voucher specimens. **Miami-Dade Co.:** FTG plot 159, accession #64-458, 25.67584°N, 80.27070°W, thousands of plants naturalized in plots 159, 198, and 180 in lowland lake margins in FTG and adjacent mangrove habitat in Matheson Hammock, grows intermixed with native mangrove species, 9 Feb 2009, *Possley 95* (FTG, USF); FTG plot 81 (naturalized, not accessioned), 25°40'34.13"N, 80°16'24.68"W, thousands of plants naturalized from these in lowland lake margins in FTG and adjacent manrove habitat in Matheson Hammock, grows intermixed with native mangrove species, 11 Jun 2009, *Possley 96* (FTG, USF).

Mimusops coriacea (A. DC.) Miq. (Sapotaceae). Native to Madagascar, Comoros, Seychelles, and the Mascarene Islands, it is cultivated and naturalized elsewhere in the New and Old world tropics. Our specimens were verified by Terry Pennington (K). This is the first report of it naturalized in the continental United States.

Voucher specimens. **Broward Co.:** Central Broward Regional Park, just N of Sunrise Blvd. between I-95 & Florida Turnpike, T49S, R42E, Sec. 31, 23 Jul 2008, *Howell 1064* (USF); John U. Lloyd Beach State Park, near entrance and extending into maritime hammock and hind dune, occasional, 26.059051°N, 80.113863°W, 11 May 2009, *Lockhart & Hanes 587* (USF).

Pentas lanceolata (Forssk.) Deflers (Rubiaceae). Native to northern Africa, it is commonly cultivated in the tropics and subtropics worldwide as an ornamental where it has sometimes become naturalized. This is the first report of the species naturalized in the continental United States.

Voucher specimen. **Miami-Dade Co.:** Hattie Bauer Hammock, The Orchid Jungle, E side of SW 157 Ave. at theoretical 268 St., disturbed ground at park entrance on 157 Ave., 25.518421°N, 80.444942°W, 23 Feb 2002, *Bradley 2192* (FTG)

Philodendron hederaceum (Jacq.) Schott var. **oxycardium** (Schott) Croat (Araceae). Native to Mexico, this species is frequently cultivated as an ornamental. It was planted along nature trails in Hattie Bauer Hammock when it was commercially operated as the tourist attraction Orchid Jungle. Now a county preserve, it has spread aggressively throughout undisturbed portions of the rockland hammock there. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Miami-Dade Co.:** Hattie Bauer Hammock, E side of SW 157 Ave. at theoretical 268 St., abundant in rockland hammock throughout property where it spread from cultivation along nature trail, 24 Jun 2009, *Bradley 2675* (FTG, USF).

Pimenta dioica (L.) Merr. (Myrtaceae). Native to the West Indies, Mexico, and Central America, it is frequently cultivated in the Old and New World tropics as a food flavoring (allspice) and sometimes for medicinal use. It is naturalized in Puerto Rico, the Virgin Islands, Bermuda, Hawaii, and other Pacific Islands. Commonly cultivated in southern Florida, it has escaped into multiple rockland hammocks and disturbed sites in Miami-Dade County. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Miami-Dade Co.:** Meissner Hammock, S of theoretical SW 300 St., 0.1 mi E of 202 Ave., frequent inside western edge of rockland hammock, 19 Jun 2009, *Bradley 2681* (FTG, USF).

Pithecellobium bahamense Northr. (Fabaceae). Native to the central Bahamas (Andros, New Providence, Exuma, and Long Island) and northern Cuba, it is here reported for the continental United States. The Monroe County keys population consists of over 200 plants in a small, dense colony in an undisturbed pine rockland with no evidence of cultivation. This appears to be a native population. It was also found by Paula Cannon and Ben Edwards in 2006. Although experimental evidence is lacking, Barneby and Grimes (1997) propose this taxon to be a hybrid between *P. keyensis* Britton and *P. histrix* (A. Rich.) Benth. based on intermediate morphology and sympatric distribution. Of the supposed parental species, only *P. keyensis* occurs in Florida. *Pithecellobium bahamense* is readily distinguished from *P. keyensis* in Florida by having stipular spines and the leaflets 1–2.5 cm long (versus spines lacking and the leaflets 3–7 cm long in *P. keyensis*).

Voucher specimen. **Monroe Co.:** Big Pine Key, National Key Deer Refuge; ca. 180 m W of Key Deer Blvd., ca. 460 m N of Big Pine Street, opposite parking lot for Watson Hammock Nature Trail, 18 Oct 2007, *Bradley & Barry 2662* (USF).

Polyalthia suberosa (Roxb.) Thwaites (Annonaceae). Native to Asia, it is widespread as a cultivated ornamental in the Old and New World tropics. This is the first report of it naturalized in the continental United States. In addition to the localities below, it is also well established within rockland hammock habitat at Simpson Park in the City of Miami.

Voucher specimens. **Miami-Dade Co.:** Matheson Hammock Park, south portion, naturalized in undisturbed rockland hammock along border with Montgomery Botanical Center, 25°39'49.88948"N, 80°16'48.67558"W, 12 Dec 2003, *Gann & Thornton 1209* (FTG); Matheson Hammock Park, S of Schoolhouse Road endpoint, 25.38360°N, 80.27593°W, 14 Dec 2004, *Possley & Prieto 72* (FTG).

Radermachera sinica (Hance) Hemsl. (Bignoniaceae). Native to subtropical Asia, it is cultivated widely as a houseplant and outdoors in the Old and New world tropics as an ornamental. It is naturalized in Hawaii. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Miami-Dade Co.:** Fire suppressed pine rockland at SW corner of SW 296 St. & 197 Ave., frequent in understory, 25.490747°N, 80.510248°W, 24 Jun 2009, *Bradley 2677* (FTG, USF).

Rousselia humilis (SW.) Urb. (Urticaceae). This weedy species native to the West Indies, Mexico, and Central America is here reported for the first time from continental United States. Our specimens were determined in duplicate by David E. Boufford (A).

Voucher specimens. **Broward Co.:** Pembroke Park, 426 Marine Dr., 31 Dec 2003, *Guertin 6993* (USF); Coconut Creek Maple Swamp Natural area, ca. 1.5 mi SE of West Dixie Bend, T48S, R42E, Sec 8, 17 Sep 2008, *Howell 1074* (USF).

Senna atomaria (L.) H.S. Irwin & Barneby (Fabaceae). Native to Mexico, the West Indies, Central America, and northern South America (Columbia and Venezuela) and recently introduced in the Old World for agroforestry purposes. It is rare in cultivation in Florida and the origin of material at Dismal Key is uncertain; possibly a recent natural range extension. This is the first report of it in the continental United States.

Voucher specimen. **Collier Co.:** Dismal Key, Ten Thousand Islands National Wildlife Refuge, 10.4 mi W of Everglades City, center of island, shell mound in hardwood woodland, 2 Oct 2008, *Barry & Sadle s.n.* (FTG, USF).

Solanum umbellatum Mill. (Solanaceae). A weedy species native to Mexico, Central America, South America, and the West Indies, it is related to *S. erianthum* D. Don, a widespread species native to peninsular Florida (Roe 1967). This is the first report of the species naturalized in the continental United States.

Voucher specimens. **Miami-Dade Co.:** edge of farm field 0.25 mi W of Krome Ave. (SW 177 Ave.) on N edge of SW 288 St., small population of a few plants, 25°30'00.3"N, 80°28'54.05"W, 16 Dec 2008, *Bradley 2665* (FTG, USF); Silver Palm Groves Hammock Preserve, frequent in shrubby disturbed area on oolitic limestone adjacent to pine rockland, rockland hammock, and an avocado grove, with *Chromolaena odorata*, *Bidens alba*, and other weeds, ca. 850' N of SW 232 St., ca. 70' W of theoretical 142 Ave., Easting 558056, Northing 2826371 (UTM17N, WGS84), 3 May 2006, *Bradley & Green 2646* (FTG, USF).

Stellaria parva Pedersen (Caryophyllaceae). A species native to South America and introduced in Texas and Louisiana (USDA, NCRS 2009), large colonies of it were recently discovered in Colt Creek State Park, Polk County.

Voucher specimens. **Polk Co.:** Colt Creek State Park, ca. 3.27 km SSE of FL 471 bridge over the Withlacoochee River, ca. 4.5 km NNE of the junction of FL 471 and US 98, edge of pasture near hydric hammock, 28°17'13"N, 82°2'21"W, 3 Apr 2008, *Kunzer et al. 2317* (USF); Colt Creek State Park, ca. 2.6 km SSE of FL 471 bridge over the Withlacoochee River, ca. 5.3 km NNE of the junction of FL 471 and US 98, trail in ecotone between pasture and cypress [*Taxodium*] swamp, 28°17'38"N, 82°2'23"W, 15 Apr 2008, *Kunzer & Hansen 2383* (USF); Colt Creek State Park, ca. 2.6 km SSE of FL 471 bridge over the Withlacoochee River, ca. 5.3 km NNE of the junction of FL 471 and US 98, pasture edge adjacent to hydric hammock, 28°17'13"N, 82°2'21"W, 15 Apr 2008, *Kunzer & Hansen 2390* (USF); Colt Creek State Park, ca. 2.6 km SSE of FL 471 bridge over the Withlacoochee River, ca. 5.3 km NNE of the junction of FL 471 and US 98, pasture edge adjacent to *Taxodium* swamp, 28°17'13"N, 82°2'21"W, 15 Apr 2008, *Kunzer & Hansen 2392* (USF).

Trema orientalis (L.) Blume (Ulmaceae). Native to Asia, Africa, and Australasia, it is cultivated in the New and Old world tropics for a variety of uses and is naturalized in Hawaii. A population was found in Miami-Dade County by Bradley and Roger Hammer in 1996 at the USDA Subtropical Horticultural Research Station. Plants were formerly cultivated at the Station where it was introduced from Mozambique. It subsequently spread into a fire suppressed pine rockland. This is the first report from the continental United States. In 2009, it was found along the historical eastern shoreline of Lake Okeechobee in Martin and Palm Beach Counties. Whether the source of this population was from the Miami-Dade plants is unknown.

Voucher specimens. **Miami-Dade Co.:** USDA Subtropical Horticultural Research Station, Chapman Field, Old Cutler Road just S of Snapper Creek, small trees naturalized along edge of a degraded pine rockland fragment, recruits frequent here, 25.641266°N, 80.296019°W, 1 Jun 2004, *Bradley 2579* (FTG). **Martin Co.:** common along historical shoreline of Lake Okeechobee, E side of US 441, ca. 2.4 mi S of Okeechobee County line, ca. 8 mi N of Kanner Highway, with *Sabal palmetto*, *Taxodium ascendens*, *Celtis laevigata*, and *Schinus terebinthifolia*, 27.09336°N, 80.65745°W, 18 Oct 2009, *Bradley 2687* (FTG). **Okeechobee Co.:** a few plants along western edge of US 441, 0.2 mi N of Martin Co. line, with *Schinus terebinthifolia*, 27.12389°N, 80.67926°W, 18 Oct 2009, *Bradley 2580* (FTG).

Trichosanthes cucumerina L. (Cucurbitaceae). Native to tropical Asia and Australasia, it is cultivated for food, medicine, and as an ornamental in tropical areas of the Old and New World. This is the first report of it naturalized in continental United States.

Voucher specimens. **Broward Co.:** Woodmont Natural Area, T49S, R41E, Sec. 4, vining over cypress [*Taxodium*] trees, 31 Oct 2002, *Howell 593* (USF); Doris Forman Natural Area, T47S, R41E, Sec. 35, 1 Oct 2003, *Howell 723* (USF).

Triplaris melaenodendron (Bertol.) Standl. & Steyerm. (Polygonaceae). Native to Mexico and Central America, it is occasionally cultivated as an ornamental. This is the first report of it naturalized in the continental United States.

Voucher specimen. **Collier Co.:** N edge of Oil Well Road (C-858), 6.5 driving mi W of FL 29, 8.7 mi SSW of Immokalee, small colony of several dozen plants consisting of several age classes (trees to seedlings) of plants spreading by seed, 24 Nov 2007, *Bradley 2670* (FTG, USF).

Wissadula amplissima (L.) R.E. Fries (Malvaceae). A weedy species native to Mexico, Central America, South America, the West Indies, and the continental United states in Texas. It also occurs in Louisiana (USDA, NRCS, 2009). It is reported here for the first time as naturalized in Florida.

Voucher specimen. **Collier Co.:** Picayune Strand State Forest, growing among cleared road on the SE portion of the preserve, associated plant species include *Sida acuta* and *Urena lobata*, 13 Feb 2008, *Green & Barry 46* (FTG).

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BOOK REVIEW

Luis Digo Gómez y Alba L. Arbeláez (authors) and W.D. Stevens, Olga Martha Montiel y Amy Pool (eds) and Alba L. Arbeláez (ilustradora). 2009. **Flora de Nicaragua, Helechos (Tomo IV).** (ISBN 978-1-930723-87-0, hbk.). Monogr. Syst. Bot. Missouri Bot. Gard. Vol. 116 (ISSN 0161-1542). Missouri Botanical Garden Press, P.O. Box 299, St. Louis, Missouri 63166-0299, U.S.A. (**Orders:** www.mbgpress.org). $109.00, 348 pp., distribution maps, 151 line drawings, 8 1/2" × 11".

Contenido:
Prefacio (Luis Diego Gómez)
Agradecimientos
Introducción (W.D. Stevens)
Evaluación preliminar del estado de conservación de las especies de helechos (Olga Martha Montiel)
Notas acerca del formato
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Bibliografía General
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Índice

Congratulations to the authors, editors, and illustrator for the fourth and final volume of the *Flora of Nicaragua*. The final volume is all about ferns and lycophytes. The volume is arranged alphabetically by genus and species. Generic descriptions are followed with a list of references and then species treatments. Keys are included for genera with more than one species. A distribution map for each species is included in the text. To top things off, beautiful line drawings—grouped together in full page plates in the back of the book—illustrate some aspect of each species (633). What a fantastic contribution. The book is in Spanish but don't let that stop you from adding this good fern book to your collection of fern literature!—*Barney Lipscomb, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

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VASCULAR FLORA AND EDAPHIC CHARACTERISTICS OF SALINE PRAIRIES IN LOUISIANA

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ABSTRACT

Saline prairies are unique, small-scale grassland communities found in the south-central United States. These grasslands occur on natric soils, which have high levels of exchangeable sodium, resulting in adverse physical properties including poor internal drainage and aeration. Subsurface natric horizons can contribute to harsh droughtiness. Landscape features within our study sites included broad flats, slicks, wet depressions, and pimple mounds. The flora of two study sites totaled 219 species and infraspecific taxa distributed among 148 genera and 65 families. Largest families were Poaceae, Cyperaceae, and Asteraceae with 39, 22, and 20 species, respectively. Exotic species totaled 17 (7.8%) and species rare at the state or global level totaled 20 (9.1%). *Geocarpon minimum*, which is federally-listed as threatened, was present at both study sites and was very abundant at one site. Our survey resulted in the discovery of two state records (*Lechea san-sabeana* and *Saxifraga texana*) and rediscovery in Louisiana of three taxa (*Carex arkansana*, *Gratiola flava*, and *Minuartia drummondii*). Soil pedon descriptions and chemical analyses confirmed the natric soil classification. Particle size analysis indicated that pimple mound soils were sandier than soils of other landscape positions, which were predominantly silty. Concentrations of Ca, Mg, and Na were elevated in broad flat and slick soils versus pimple mound soils. Surface horizons were mostly acidic with low sodium adsorption ratios (SAR) for most soil cores. Natric horizons were characterized by alkaline pH and SAR values often well above 15, and ranged in depth from 0 to 48 cm. We qualitatively relate flora to edaphic characteristics of each landscape position. Saline prairies at our study sites appear to be edaphically maintained as grasslands. We briefly discuss community classification in light of soils evidence.

RESUMEN

Las praderas salinas son comunidades herbáceas únicas a pequeña escala, que se encuentran en el sur-centro de los Estados Unidos. Estos herbazales se dan en suelos nátricos, que tienen niveles altos de sodio intercambiable, dando como resultado propiedades físicas adversas como drenaje y aireación interna pobres. Los horizontes nátricos del subsuelo pueden contribuir a una fuerte sequía. Las unidades de paisaje en nuestros lugares de estudio incluyeron llanuras, slicks, depresiones húmedas, y pimple mounds. La flora de dos lugares de estudio totalizó 219 especies y taxa infraspecíficos distribuidos en 148 géneros y 65 familias. Las familias más grandes fueron Poaceae, Cyperaceae, y Asteraceae con 39, 22, y 20 especies, respectivamente. Las especies exóticas fueron 17 (7.8%) y las especies raras a nivel estatal o global fueron 20 (9.1%). *Geocarpon minimum*, que está como amenazada en la lista federal, estaba presente en ambos sitios de estudio y era muy abundante en uno de ellos, Dalton/Dickson Saline Prairie. Nuestro estudio dio como resultado el descubrimiento de dos especies para el estado (*Lechea san-sabeana* y *Saxifraga texana*) y el redescubrimiento de tres taxa en Louisiana (*Carex arkansana*, *Gratiola flava*, y *Minuartia drummondii*). Las descripciones del suelo y análisis químicos confirman la clasificación nátrica del suelo. Los horizontes nátricos en las llanuras y slicks estaban en la superficie o muy cerca de ella, a una profundidad variable de 0 a 46 cm. El análisis del tamaño de partícula indicó que los suelos de los pimple mound eran más arenosos que los que estaban en otras posiciones, que eran predominantemente sedimentarios. Las concentraciones de Ca, Mg, y Na eran elevadas en los suelos de llanuras y slick a diferencia de los suelos de los pimple mound. Los horizontes superficiales eran acídicos con tasas bajas de absorción de sodio (SAR) en la mayoría de los núcleos de suelo. Los horizontes nátricos se caracterizaban por su pH alcalino y valores de SAR superiores a 15. Relacionamos cuantitativamente la flora con las características edáficas con cada unidad de paisaje. Las praderas salinas en nuestro lugar de estudio parecen estar mantenidas edáficamente como praderas. Discutimos brevemente la clasificación de la comunidad a la luz de las pruebas edáficas.

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INTRODUCTION

Saline prairies are typically small-scale natural grassland communities that occur on soils with unique chemical and physical properties (Louisiana Natural Heritage Program 2009b). Saline prairies occur in the West Gulf Coastal Plain of central and northwestern Louisiana, eastern Texas, and southern Arkansas (Louisiana Natural Heritage Program 2009b; NatureServe 2009), in the Arkansas River Valley of western Arkansas (Pittman 1993), and in the Mississippi River Alluvial Plain of eastern Arkansas (Arkansas Multi-Agency Wetland Planning Team 2001). In Louisiana, pre-settlement aerial coverage of saline prairies is estimated to have been fewer than 800 ha, with only 10 to 25 percent currently remaining (Lester et al. 2005). Threats to saline prairies include development and maintenance of roads and utility corridors, grazing practices, incompatible forestry practices, invasive species (e.g., feral pigs), oil and gas drilling, and vehicular traffic and recreational use (Lester et al. 2005). The community is currently considered globally imperiled with a rarity ranking of G1G2 (NatureServe 2009). Largely due to the presence of the federally-listed *Geocarpon minimum*, saline prairies are being studied floristically and edaphically (McInnis et al. 1993; Keith et al. 2004; Lester et al. 2005; Arkansas Natural Heritage Commission 2006; Diggs et al. 2006; MacRoberts et al. 2009b). The purpose of our study is to add descriptive floristic and edaphic information to the growing body of literature on saline prairies.

PHYSICAL SETTING, GEOLOGY, AND SOILS

Louisiana saline prairies occur on fluvial terraces adjacent to active floodplains. The soils formed in loamy late Pleistocene sediments (Soil Survey Staff 1991; Soil Survey Staff 1998) that correspond to the Prairie Terrace formation (Snead & McCullough 1984). The Prairie Terrace consists of reworked sediments that eroded from adjacent higher Pleistocene terraces and/or Tertiary formations (Huner 1939). The Prairie Terrace is the youngest and lowest in elevation of the Pleistocene terraces, and possibly formed during interglacial periods when sea level was high, thus reducing stream gradients and allowing deposition of fine sediments (Murray 1948). Three soil series are known to support saline prairies in Louisiana: Bonn, Brimstone, and Lafe. The following are taxonomic names for these soil series: Bonn series: fine-silty, mixed, superactive, thermic Glossic Natraqualfs; Brimstone series: fine-silty, siliceous, superactive, thermic, Glossic Natraqualfs; Lafe series: fine silty, mixed, active, thermic, Glossaquic Natrudalfs (Soil Survey Staff 2006). These are examples of natric soils, also called alkali, sodic, sodium, or solonetz soils (Horn 1962; Horn et al. 1964; Pettry et al. 1981; Soil Survey Staff 1998). Natric soils have a type of argillic horizon (containing illuviated clays) called a natric horizon that is characterized by high levels of exchangeable Na (≥ 15%) and by columnar/prismatic or blocky structure (Soil Survey Staff 2006). Natric soils are often associated with arid or semi-arid environments where low precipitation and high evaporation demand result in incomplete leaching of salts. Accumulation of Na in soils in humid environments has been attributed to interruption of leaching by impervious subsoil horizons (Smith 1937; Pettry & Switzer 1998). In natric horizons, soil hydraulic properties are degraded due to the dispersal of clay particles by Na^+. Dispersion of clay particles produces a natric horizon that is dense, compact, and slowly permeable to air and water (Smith 1937; Horn 1962, Hassett & Banwart 1992; Pettry & Switzer 1998). Physical properties of natric soils can reduce soil water storage and transport capacity resulting in droughty conditions (Rengasamy et al. 2003). The natric horizon functions like a claypan by perching water during wet periods, preventing upward movement of water during dry periods, and preventing plant roots from exploiting water deeper in the soil (Horn 1962; Pettry & Switzer 1998). Thus, soils are often either extremely dry or waterlogged, a condition described as xerohydric (NatureServe 2009). Hydrolysis of Na and formation of compounds such as NaOH and Na_2CO_3 result in strongly alkaline pH in natric horizons (Horn 1962). Natric soils have been the subject of considerable study due to the effects of their adverse physical properties on agricultural crop production (e.g., Shainberg et al. 1980; Rengasamy & Olsson 1991; Rengasamy et al. 2003; Vukadinović & Rengel 2007).

In studies of natric soils in eastern Arkansas and in Illinois, the weathering of Na-rich feldspars of the loess parent material was implicated as the source of Na (Wilding et al. 1963; Horn et al. 1964). Horn (1962) and Horn et al. (1964) suggest that possible sources of Na in non-loessal natric soils in Arkansas include incomplete leaching of salts adhering to flood-deposited sediments, and evaporation of salinized water that moves upward to the soil surface. The latter of these sources seems possible in saline prairies in central Louisiana, specifically in Winn Parish, where they often occur above large amounts of Jurassic Louann salt (Andrews 1960; Ingram 1991).

Depth to natric horizon is apparently important in determining soil physical and chemical properties and associated vegetation. In a study of natric soils in Arkansas, Horn et al. (1964) recognized soil groups based on depth to natric horizon, with the most extreme category being represented by the Lafe series, which in their study had a natric horizon within ~ 25 cm of the surface. Lafe soils were characterized by drought-tolerant species such as *Aristida* L. spp., *Opuntia* spp., and *Quercus stellata* (Horn et al. 1964).

The general appearance of a saline prairie is often pasture-like (Fig. 1). Saline prairies in Louisiana are open, usually with a short to medium-height grass canopy. The density of grasses is variable but is sparse relative to coastal and calcareous prairies, also found in Louisiana. We refer to the portions of the prairies with fairly continuous herbaceous cover as "broad flats." Broad flats account for the largest portions of saline prairies, the other landscape features usually being inclusional. Wet depressions are often embedded features in northwestern Louisiana saline prairies. These depressions tend to be shallow and support wetland plant species. Small "slicks" nearly devoid of vegetation occur where Na has been brought to the surface or where the natric horizon is very near the surface or exposed (Fig. 2). The soil surface within slicks often has a cryptogamic crust composed of algae, mosses, and lichens. Smaller slicks may be completely covered by this crust, while on larger slicks it may occur only along the margins. Pimple mounds (Fig. 3) are often scattered about and support trees and shrubs of various density, but are sometimes almost entirely open and grassy. Pimple mounds are enigmatic landscape features. Cain (1974) postulates that pimple mounds may have been formed by rill erosion occurring in a former climate characterized by alternating periods of drought and heavy rainfall. A more recent study provides evidence that pimple mounds are relict nebkhas, formed by deflation and subsequent deposition of soil by wind during prolonged droughts of the late Holocene period (Seifert et al. 2009). Seifert et al. (2009) point out that pimple mounds often coincide with claypan soils, which might have accentuated the effects of drought.

STUDY SITES AND METHODS

Starting in 2005, we began searching for saline prairies mainly in Caddo and DeSoto parishes in northwestern Louisiana. The Louisiana Natural Heritage Program database had no occurrence records of saline prairies for that region of the state at that time despite the relative commonness of Bonn silt loam in Caddo and De Soto parishes (Soil Survey Staff 1980; Soil Survey Staff 1991).

Using the soil surveys, Bonn soil map units were identified, and then located on 7.5' topographic maps and aerial photographs. Saline prairies and other inclusional prairies and barrens are often symbolized by irregular openings on topographic maps. The signature on dormant season ("leaf off") aerial photos is brownish gray, indicating that the herbaceous layer is composed of warm season species (dead at time photo was taken) rather than cool season (these would appear pinkish or reddish) (Fig. 4). Pimple mounds and depressions are often evident on aerial photos (Fig. 4). We examined soil surveys of parishes adjacent to areas containing Bonn soil map units as well and scanned the correct landscape position looking for irregular openings. Apparently Bonn soils or related soil series were overlooked in Bienville and Sabine Parishes. Confirmed saline prairies occur in these parishes on Guyton soils or map units containing the Guyton series in complex with other soils (Soil Survey Staff 1997; Soil Survey Staff 2001). Once potential saline prairies were identified, ownership of the sites was determined, and after gaining permission for access, the sites were visited for ground inspection. Since 2005, 10 new saline prairie occurrences have been documented (Louisiana Natural Heritage Program 2009a). Seven of these were discovered in Bienville, Caddo, De Soto, and Red River Parishes using the process described above. Three saline prairies were confirmed in Sabine Parish after being informed of their potential occurrence by a landowner and a colleague. Locations of extant

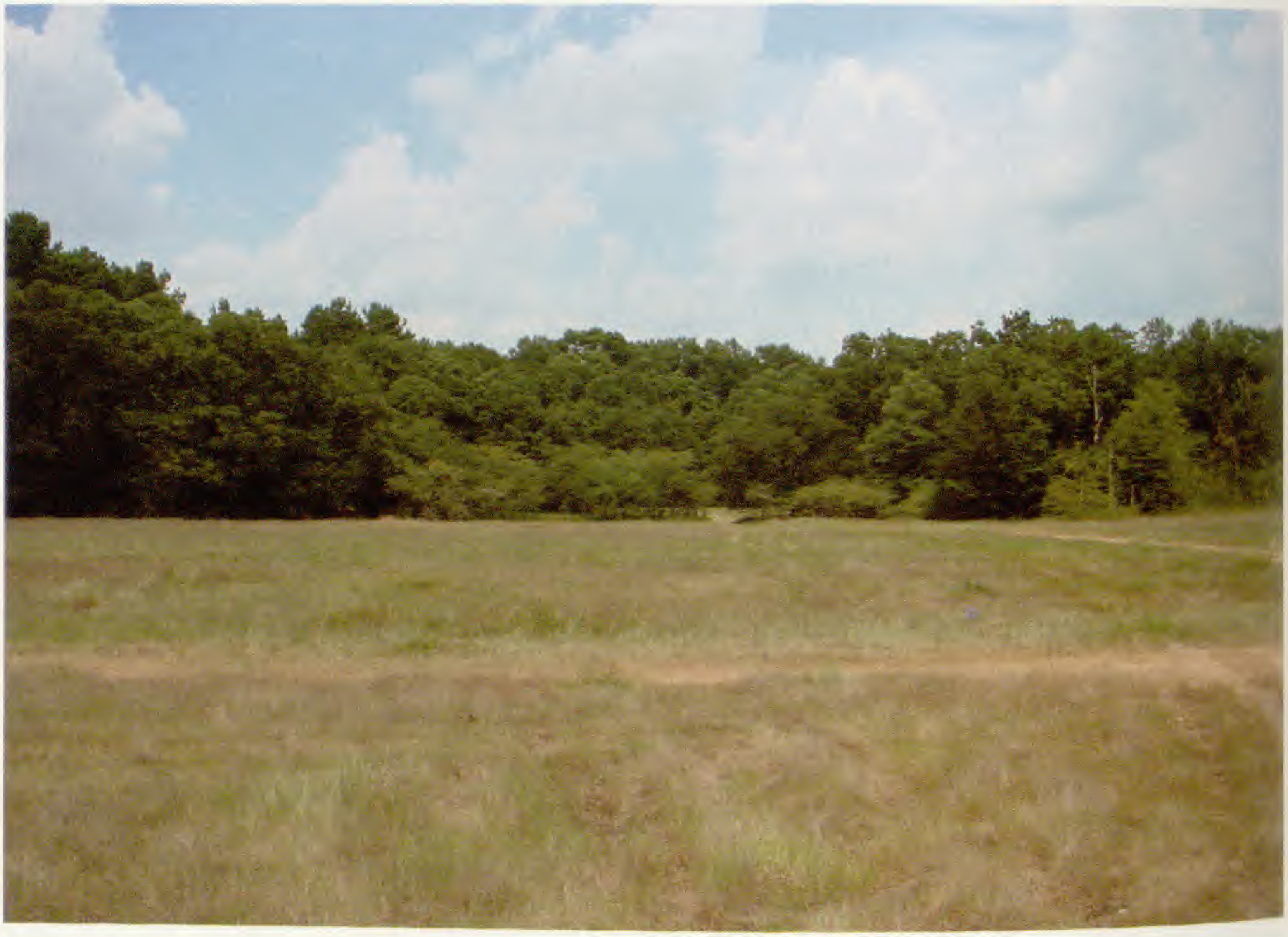

Fig. 1. Representative panoramic view of Barron Road Saline Prairie, Caddo Parish, Louisiana. Photo taken in July 2005.

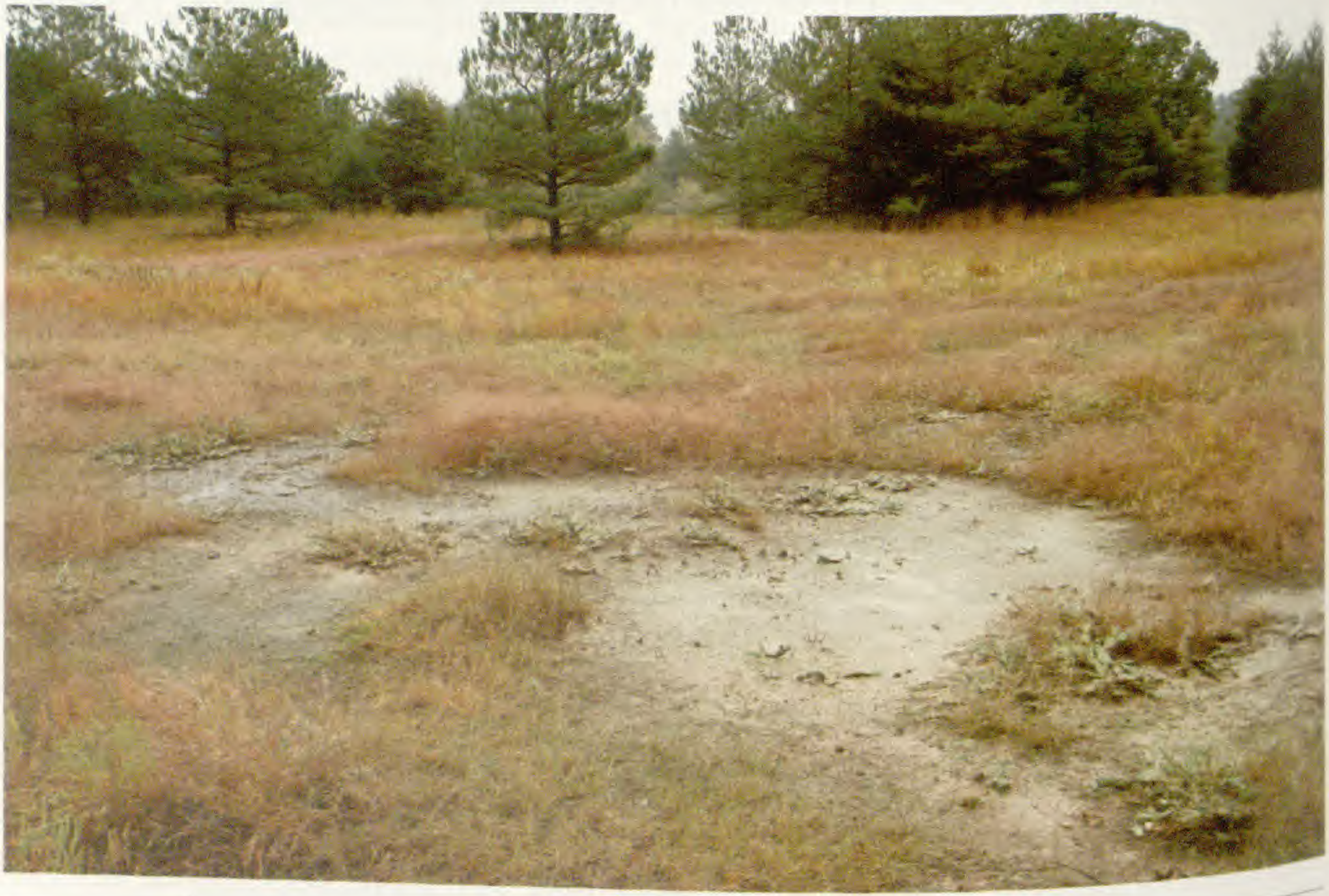

Fig. 2. Slick in Dalton/Dickson Saline Prairie, De Soto Parish, Louisiana. Photo taken in October 2006.

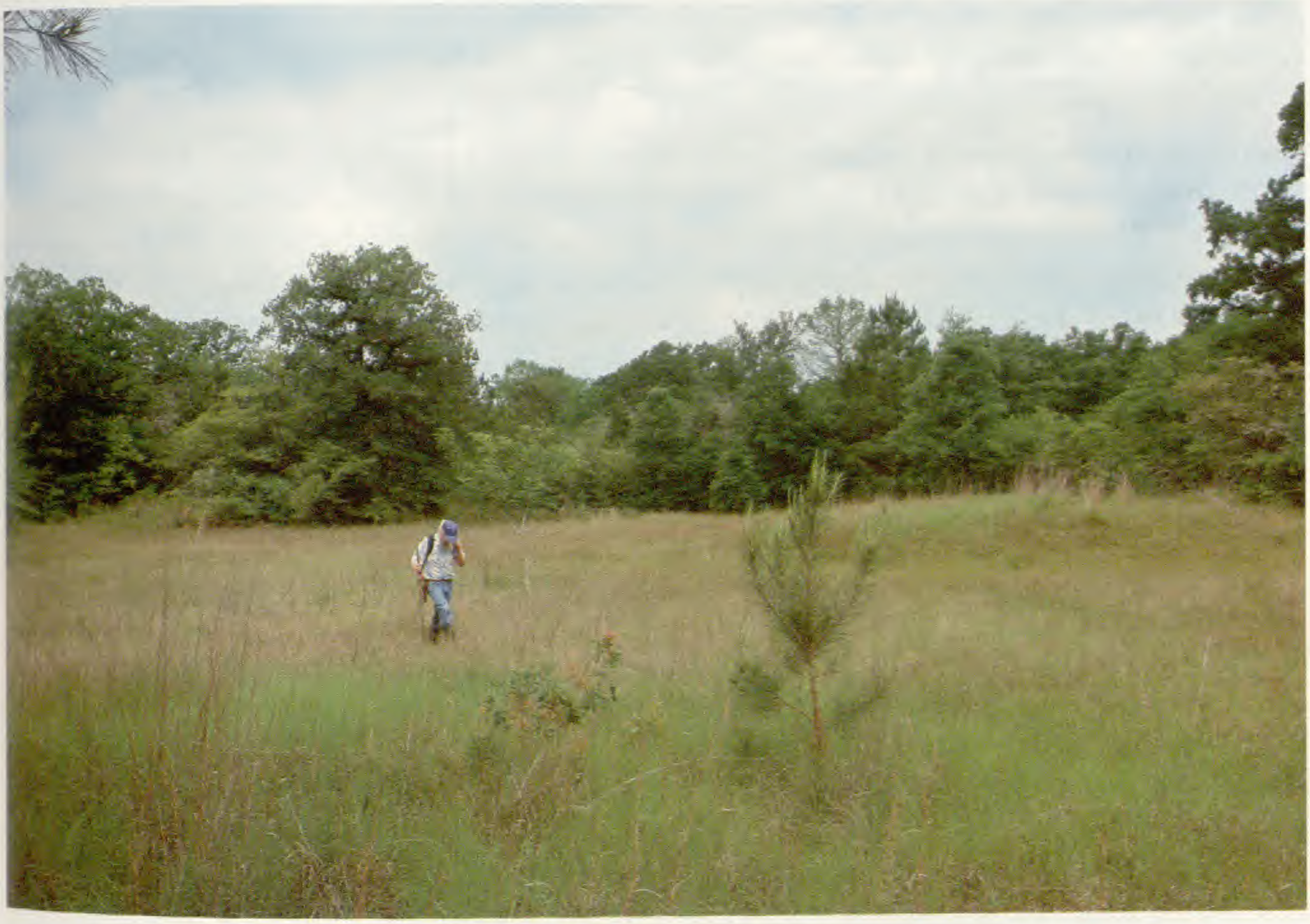

Fig. 3. Pimple mounds in Dalton/Dickson Saline Prairie, De Soto Parish, Louisiana. Photo taken in May 2006.

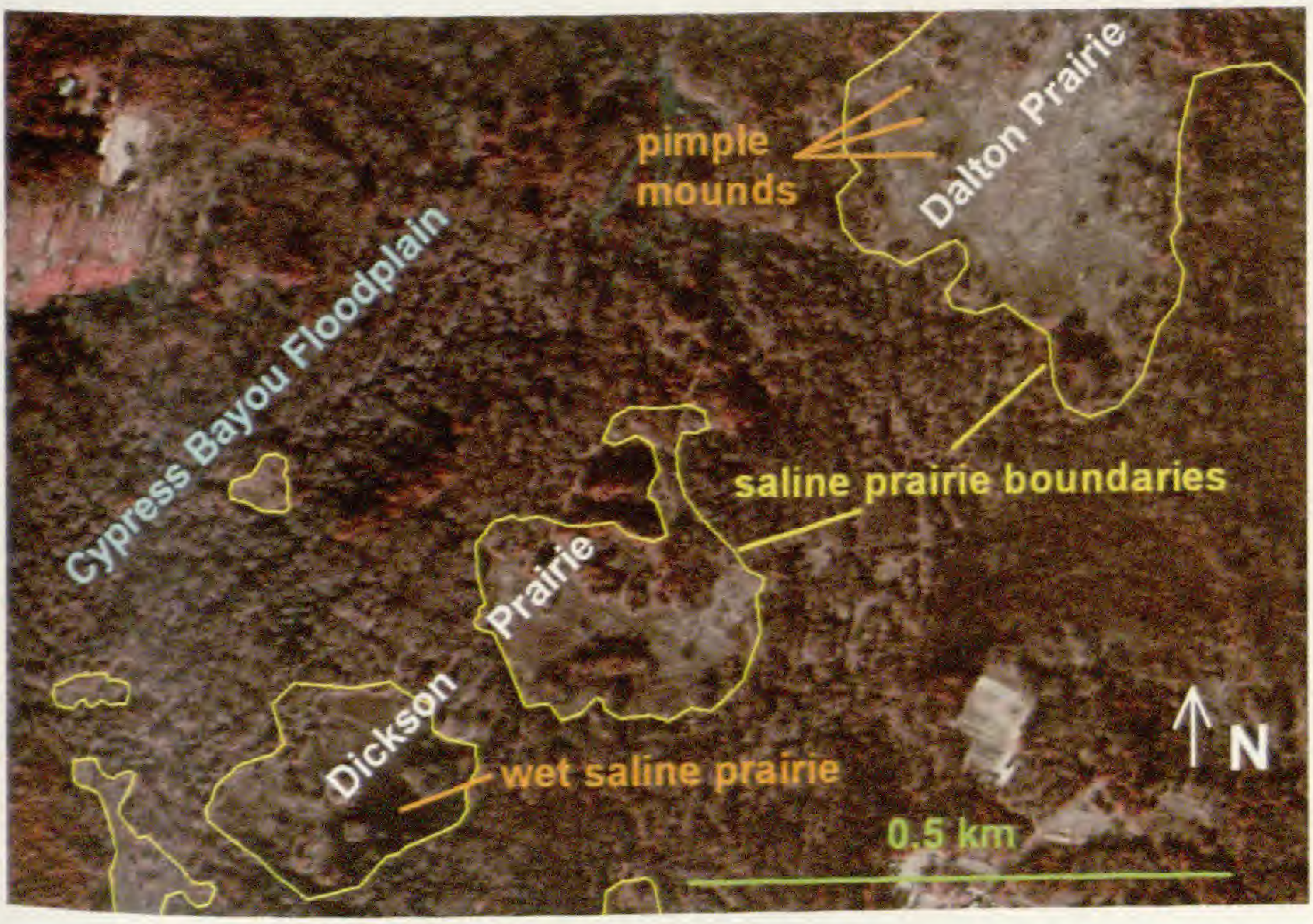
Dalton Prairie
pimple mounds
Cypress Bayou Floodplain
saline prairie boundaries
Prairie
Dickson
wet saline prairie
N
0.5 km

Fig. 4. 2004 dormant season, color infrared aerial photograph of portions of the Dalton/Dickson Saline Prairie complex, De Soto Parish, Louisiana.

saline prairies in Louisiana are presented in Figure 5. Cursory surveys were conducted at all sites to assess habitat quality and search for rare species. Two sites were more intensively studied and are the primary focus of this paper.

Barron Road Saline Prairie in southern Caddo Parish (32°21'13"N, 93°47'32"W) was discovered in July, 2005. This 6 ha site is situated just above the floodplain of Boggy Bayou, which empties into Wallace Lake. The prairie elevation is in the range of 46 to 49 m above sea level. The prairie is surrounded on its upland side by oak-pine-hickory woodlands and on its lowland side by bottomland hardwood forest that occupies the Boggy Bayou floodplain. Pimple mounds, measuring between 12 m and 33 m in diameter and <1 to 1.5 m high, are scattered over the prairie. Shallow wet depressions and slicks are occasional. The prairie has several roads through it and has been damaged by off-road vehicle use. At one time, establishment of loblolly pine (*Pinus taeda* L.) was attempted (S. Evans, pers. comm.); however, survival was extremely poor everywhere but on the pimple mounds, where even-aged, spindly trees have persisted.

Dalton/Dickson Saline Prairie, located in northern De Soto Parish (32°18'28"N, 93°48'24"W) about 5 km SSE of Barron Road Saline Prairie, consists of a complex of numerous small to large openings totaling 53 ha. It is positioned above the floodplain of Cypress Bayou, which also feeds into Wallace Lake. Most of the prairie openings are within 50 to 52 m in elevation. Pimple mounds and small wet depressions are scattered about. Much of this prairie complex is undisturbed and of very high quality. Portions do, however, experience off-road vehicle traffic. Establishment of rye grass (*Lolium perenne* L.) in one of the larger openings was attempted. Some rye grass persists in small scale patches.

The current climate of northwest Louisiana generally provides warm and humid summers and mild winters. Precipitation is fairly evenly distributed throughout the year and totals about 116 cm annually (Climate-Zone.com 2004).

FLORISTIC STUDY

Barron Road Saline Prairie was visited and voucher specimens collected every two to three weeks (except during the winter) between July 2005 and July 2006. Dalton/Dickson Saline Prairie was surveyed frequently during 2006 to search for rare plants, which were collected along with some additional species. A more thorough collection of plants from Dalton/Dickson Saline Prairie was made during regular visits from March to October 2007. Occasional collecting was carried out into 2009. Our collecting effort included species from all landscape features including broad flats, slicks, wet depressions, and pimple mounds. Scientific names follow Kartesz and Meacham (1999), Diggs et al. (2006), and USDA, NRCS (2009), in most cases. Voucher specimens are deposited at LSU and LSUS. To determine whether a species is native or exotic we consulted USDA, NRCS (2009). Using our checklist of species found at the study sites (native species only) and data from *Flora of North America* (1993–2007), Turner et al. (2003), NatureServe (2009), and USDA, NRCS (2009), we plotted the North American distribution of species by state, region, or province to determine geographic pattern and affinity.

SOIL COLLECTION AND ANALYSIS

In order to sample the intact soil profile, soil cores were taken at three relatively undisturbed saline prairie sites: Dalton/Dickson Saline Prairie, Rambin Bayou Saline Prairie (ca 12 km south of Dalton/Dickson) and Upper Weyerhaeuser Saline Prairie (a.k.a. Saline Creek Prairie) in Winn Parish, ca 145 km to the east (MacRoberts et al. 2009a). At each prairie, one soil core was extracted from broad flat, slick, and pimple mound landscape positions at subjectively determined locations within these sites. Upper Weyerhaeuser Prairie has no pimple mounds; thus only two cores were taken there, from broad flat and slick sites. The samples were separated into horizons with each horizon morphologically described at the time of collection. A soil sample from each horizon of each core was collected and stored in a plastic bag for further analyses. Soil samples from each horizon of each core were analyzed to determine basic chemical and physical attributes. Particle size analysis, pH, electrical conductivity (EC), cation exchange capacity (CEC), and sodium adsorp-

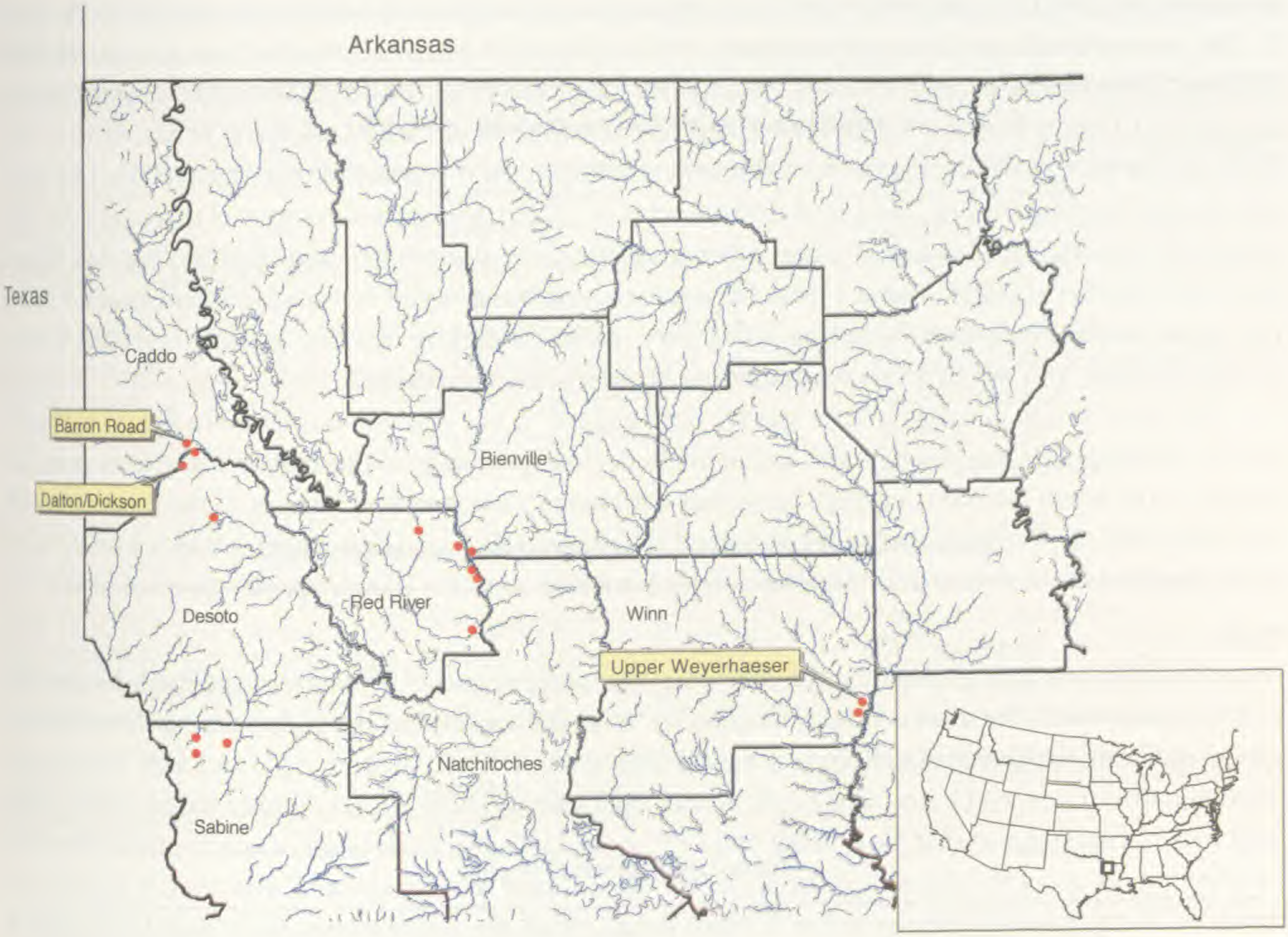

Fig. 5. Map showing locations of extant saline prairies in Louisiana.

tion ration (SAR) were determined by the Louisiana State University Coastal Wetlands Soils Characterization Lab (Wet Soils Lab). Particle size analysis was conducted for particles less than 2.0 mm. Soil samples were analyzed for sand content (0.05–2.0 mm), silt content (0.002–.05 mm), and clay content (<0.002 mm). Sand was separated by sieving. Clay content was determined using the pipette method. For pH and EC, soil samples were mixed in a 1:2 ratio (soil weight: water volume) and EC and salinity was read with an EC meter and pH with a pH meter. The 1:2 soil:water method for determining EC is a relatively inexpensive and quick method for getting an initial salinity estimate (Burt 2004). To get a more accurate measurement of EC, we re-sampled broad flat and slick soils at Rambin Bayou and Upper Weyerhaeuser Saline Prairies and analyzed each horizon for EC using the saturated paste method. For measurements of CEC and SAR, NH_4OAc was used as an extractant. CEC was determined by distillation and SAR by Inductively Coupled Plasma Mass Spectometry (ICP). Soil analyses performed by the Wet Soils Lab follow the *Soil Survey Laboratory Methods Manual* (Soil Survey Staff 1996). Soil nutrient analyses were performed by LSU Soil Testing and Plant Analysis Laboratory (LSU STPAL) using Mehlic 3 solution as an extractant (Mehlic 1984) and values reported are mehlic-extractable quantities.

RESULTS

Floristics

The saline prairie flora of both sites together included 219 species and infraspecific taxa distributed among 152 genera and 65 families (Appendix 1). Barron Road Saline Prairie had 130 species and Dalton/Dickson Saline Prairie supported 193. The two sites had 104 species in common. Poaceae was the most diverse family with 39 species. Cyperaceae and Asteraceae followed with 22 and 20 species, respectively. Exotic species accounted for 7.8% (17 taxa) of the total flora. Species rare at the global or state level totaled 20 (9.1%) (Table 2). The rarest globally are *Geocarpon minimum*, which is federally- listed as threatened and globally imperiled (G2), and *Schoenolirion wrightii*, which is globally rare (G3) (NatureServe 2009). *Geocarpon minimum* was very abundant at Dalton/Dickson Saline Prairie and rare at Barron Road (see MacRoberts & MacRoberts 2007, 2008, 2009a for monitoring data). Our field work resulted in the discovery of two state records, *Lechea sansabeana* and *Saxifraga texana* (Reid et al. 2007; Reid et al. 2008), and the rediscovery of three taxa that were previously historical for Louisiana: *Carex arkansana*, *Minuartia drummondii*, and *Gratiola flava* (MacRoberts et al. 2007; Reid et al. 2008). Table 1 lists characteristic species observed on each landscape position within the saline prairie complexes including broad flats, slicks (including broader sparsely-vegetated prairie), pimple mounds, and wet depressions (including broader-scale wet prairie).

The distribution of saline prairie species documented in our study is presented in Figure 6. Percentages of saline prairie species in states and regions decline gradually to the east and northeast and more steeply to the north and west beyond Texas and Oklahoma. One hundred percent of the taxa recorded at our study sites are found in Texas. Arkansas and Oklahoma followed Texas in percentages with 97 % and 92 %, respectively. Alabama and Mississippi both have 84% of saline prairie species reported herein.

Soils

Pedon descriptions may be found at the following web address: (www.wlf.louisiana.gov/soil-descriptions). In most cases, natric horizons are designated by an "n" suffix (e.g. Btn) in the pedon descriptions. However, the "n" suffix in horizon designations is not used with A and E horizons even if pH and SAR values qualify them as natric. The A and E horizons of slick cores from Dalton/Dickson and Rambin Bayou Saline Prairies were natric. This suggests that Na is being "wicked" to the surface in water and is concentrated at the surface by evaporation. A natric horizon in the slick core from Upper Weyerhaeuser Saline Prairie occurred at a depth of 28 cm. A natric horizon in the Rambin Bayou broad flat core was encountered at 13 cm, while in Dalton/Dickson and Upper Weyerhaeuser broad flat cores natric horizons first occurred at 46 and 25 cm, respectively. No natric horizons were encountered in the Dalton/Dickson pimple mound core. At Rambin Bayou, a natric horizon occurred at a depth of 48 cm in the pimple mound core.

Particle size distributions by landscape position are presented in Table 3. Broad flat and slick soils are in the silt loam textural class and pimple mound soil cores fall in the sandy loam textural class. There was a marked increase in clay content from E to Btn horizon in broad flat and pimple mound soil cores from Rambin Bayou Saline Prairie, and broad flat and slick cores from Upper Weyerhaeuser Saline Prairie (Table 3).

Mehlic-extractable Ca, Mg, and Na were elevated in the broad flat and slick cores compared to levels of these elements in the pimple mound cores (Table 4). Natric horizons are characterized by high pH and high SAR values (Table 4). Pimple mound soil horizons for Dalton/Dickson Saline Prairie are acidic throughout, while at Rambin Bayou, horizons were acidic until a depth of 48 cm where a natric horizon was encountered (Table 4). In broad flat cores, the upper horizons (A and E) were acidic to neutral, with subsurface horizons being alkaline (Table 4). As mentioned above, slick cores from Dalton/Dickson and Rambin Bayou were natric at the surface, the A and E horizons being alkaline and with high SAR values. Saturated paste EC values for each horizon of broad flat and slick cores from Rambin Bayou and Upper Weyerhaeuser Saline Prairies are presented in Table 4. For Upper Weyerhaeuser broad flat and slick cores, no horizon had an EC value that reached 2.0 mS cm^{-1}. For Rambin Bayou, the broad flat Btn1 and Btkn/E1 horizons had EC values of 2.204 and 2.27 mS cm^{-1}, respectively. The E1 and Btkn/E1 horizons in the Rambin Bayou slick core had respective EC values of 2.303 and 2.39 mS cm^{-1}. Electrical conductivity values of below 2.0 mS cm^{-1} are non-saline (Soil Survey Staff 1993). The horizons with EC values above 2.0 mS cm^{-1} fall in the "very slightly saline" category (Soil Survey Staff 1993).

DISCUSSION AND CONCLUSIONS

The only other comprehensive floristic study of a saline prairie that we are aware of was completed by MacRoberts et al. (2009a). Their study site was Upper Weyerhaeuser Prairie in north-central Louisiana,

Table 1. Characteristic plant species observed on various landscape positions within Barron Road and Dalton/Dickson Saline Prairies in northwest Louisiana. Species are listed alphabetically.

Broad Flats - areas with continuous herbaceous vegetation

Aristida longespica
Aristida oligantha
Astragalus distortus var. *engelmannii*
Coreopsis tinctoria
Croton willdenowii
Dichanthelium spp.
Evolvulus sericeus
Fimbristylis puberula
Gratiola flava
Hedeoma hispida
Hordeum pusillum
Houstonia spp.
Hypericum drummondii
Iva angustifolia
Krigia occidentalis
Lechea tenuifolia
Minuartia drummondii
Minuartia muscorum
Neptunia lutea
Nothoscordum bivalve
Oenothera linifolia
Opuntia sp.
Phalaris caroliniana
Ruellia humilis
Schoenolirion wrightii
Sporobolus vaginiflorus var. *vaginiflorus*
Sabatia campestris
Saxifraga texana
Tradescantia occidentalis

Slicks and sparsely-vegetated areas (inclusional to broad-scale)

Anagallis minima
Crassula aquatica
Dichanthelium oligosanthes ssp. *oligosanthes*
Geocarpon minimum
Gratiola flava
Houstonia micrantha
Houstonia pusilla
Houstonia rosea
Isolepis carinata
Krigia occidentalis
Lepuropetalon spathulatum
Oenothera spachiana
Opuntia sp.
Phemeranthus parviflorus
Plantago pusilla
Rumex hastatulus
Schedonnardus paniculatus
Sporobolus pyramidatus

Pimple Mounds (inclusional)

Andropogon ternarius
Chrysopsis pilosa
Dichanthelium sphaerocarpon var. *sphaerocarpon*
Digitaria cognata
Helianthemum rosmarinifolium
Ilex vomitoria
Lechea san-sabeana
Marshallia caespitosa
Panicum brachyanthum
Paspalum setaceum
Pinus echinata
Pinus taeda
Quercus margaretta
Rhynchospora harveyi
Schizachryium scoparium
Sideroxylon lanuginosa
Tradescantia hirsutiflora
Vaccinium arboreum

Wet Depressions (inclusional to broad-scale)

Baccharis halimifolia
Carex arkansana
Eleocharis wolfii
Euthamia leptocephala
Helenium flexuosum
Isoetes melanopoda
Juncus acuminatus
Juncus brachycarpus
Juncus dichotomus
Juncus marginatus
Limnosciadium pinnatum
Ludwigia spp.
Sagittaria papillosa
Steinchisma hians
Tridens strictus

approximately 145 km to the southeast of Barron Road and Dalton/Dickson Saline Prairies. Upper Weyerhaeuser Saline Prairie was much smaller than our sites and was notably uniform, lacking landscape features such as pimple mounds and wet depressions. It had 59 species, of which 44 (~75%) also occur at Barron Road and Dalton/Dickson Saline Prairies (MacRoberts et al. 2009a). A comparison of the flora of Upper Weyerhaeuser Prairie with that of our study sites shows that some species were conspicuous at one site and not the others. For example, *Bigelowia nuttallii* L.C. Anderson, a species characteristic of rocky glades, barrens, and eroded soils, was very common on Upper Weyerhaeuser Saline Prairie and absent from our study sites. *Opuntia* sp. was very common on our study sites and absent from Upper Weyerhaeuser Saline Prairie. (Note: species identification of our *Opuntia* material is premature pending further systematic study [L. Majure, pers. comm.].)

MacRoberts et al. (2009a) remarked that saline prairies and sandstone glades/outcrops share a number of species. In their study of three sandstone outcrops in west-central Louisiana, MacRoberts & MacRoberts

Table 2. Rare plant species documented within Barron Road and Dalton/Dickson Saline Prairies in Caddo and De Soto Parishes, Louisiana. Global and state ranks range from 1 to 5 with 1 being the most rare and 5 being demonstrably secure. Global ranks are from NatureServe (2009) and state ranks are from Louisiana Natural Heritage Program (2010).

Family	Scientific Name	Global Rank	State Rank	Comments
Amaryllidaceae	*Cooperia drummondii*	G5	S2	First records from saline prairies in Louisiana, previous records being from coastal and calcareous prairies.
Asteraceae	*Diaperia verna*	G5	S1	Apparently first record from a natural community in Louisiana, other records being from lawns and cemeteries.
Asteraceae	*Pterocaulon virgatum*	G5	S2	Elsewhere in coastal prairies and on pimple mounds in *Pinus palustris* Mill. flatwoods in southwest Louisiana.
Caryophyllaceae	*Geocarpon minimum*	G2	S2	Federally listed as threatened, one of five occurrences in Louisiana where it is restricted to saline prairies (Reid et al. 2008).
Caryophyllaceae	*Minuartia drummondii*	G5	S2	Previously historical in Louisiana (MacRoberts et al. 2007).
Caryophyllaceae	*Minuartia muscorum*	G4	S3	This element may prove to be more common in Louisiana.
Cistaceae	*Helianthemum rosmarinifolium*	G4	S2	Extant populations in Louisiana are on pimple mounds in saline prairies.
Cistaceae	*Lechea san-sabeana*	G4	S1	State record (Reid et al. 2008).
Cyperaceae	*Carex arkansana*	G4	S1	Previously known in Louisiana from one historical specimen (Reid et al. 2008).
Cyperaceae	*Eleocharis wolfii*	G3G4	S3	Global status is reviewed by McKenzie et al. (2009).
Fabaceae	*Lotus unifoliolatus*	G5	S2	Other Louisiana records are from beside railroads and thus are possibly introduced.
Grossulariaceae	*Ribes curvatum*	G4	S2	Recorded from Caddo and Desoto Parishes where it is known from mesic hardwood or mixed loblolly pine-hardwood forests.
Hyacinthaceae	*Schoenolirion wrightii*	G3	S2	In Louisiana restricted to saline prairies and sandstone glades.
Hydrophyllaceae	*Phacelia glabra*	G4	S2	Known in Louisiana from saline prairies in Bienville, Caddo, and Desoto Parishes and from an "open field" in Ouachita Parish.
Nyctaginaceae	*Mirabilis albida*	G5	S2	In Louisiana mostly known from sandhills and calcareous prairies.
Oleaceae	*Forestiera ligustrina*	G4G5	S3	Known elsewhere from northwest Louisiana from mixed hardwood-loblolly pine and hardwood slope forests.
Poaceae	*Schedonnardus paniculatus*	G5	S1	There are few other Louisiana occurrences, from calcareous and possibly coastal prairies.
Portulacaceae	*Phemeranthus parviflorus*	G5	S3	In Louisiana restricted to saline prairies and sandstone glades.
Saxifragaceae	*Saxifraga texana*	G4	S1	State record (Reid et al. 2007)
Scrophulariaceae	*Gratiola flava*	G4	S1	Previously historical in Louisiana (MacRoberts et al. 2007)

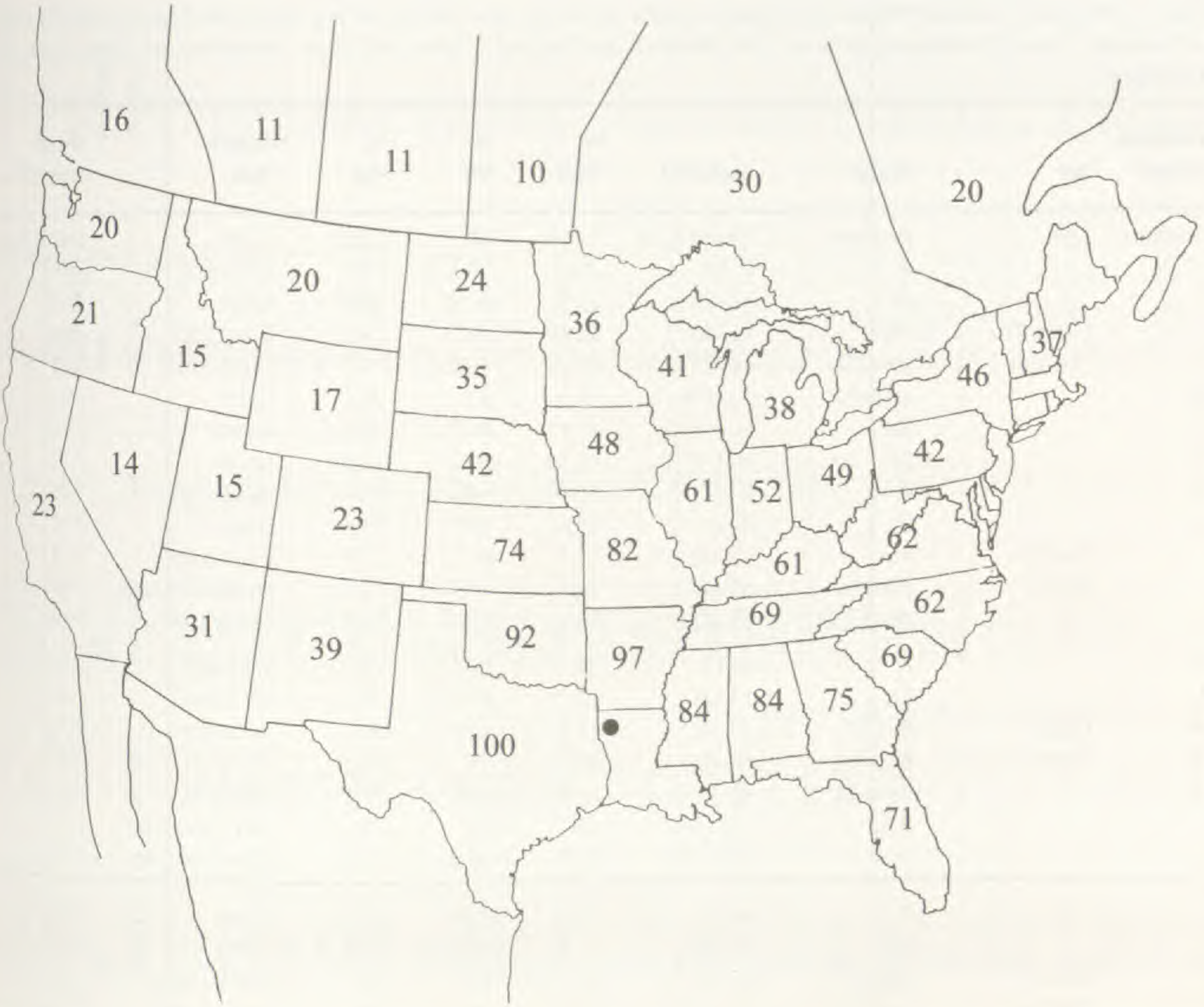

Fig. 6. Map showing North American distribution of saline prairie flora documented at Barron Road and Dalton/Dickson Saline Prairies in northwest Louisiana. Each number is a percentage of the saline prairie flora that occurs in the particular state, province, or region.

(1993) reported 136 taxa. Of these, 46 taxa are also found in our study sites. Species reported from sandstone outcrops that were conspicuous at Dalton/Dickson and Barron Road Saline Prairies include *Aristida longispica*, *A. oligantha*, *Croton willdenowii*, *Dichanthelium aciculare*, *Evolvulus sericeus*, *Fimbristylis puberula*, *Hedeoma hispida*, *Phemeranthus parviflorus*, *Sabatia campestris*, and *Schoenolirion wrightii* (MacRoberts & MacRoberts 1993).

Coastal and calcareous prairies are characteristically dominated by perennial grasses including *Andropogon gerardii* Vitman, *Schizachyrium scoparium*, *Sorghastrum nutans* (L.) Nash, and *Panicum virgatum* L.. (MacRoberts et. al. 2009b; Allen et al. 2001). Of these, *S. scoparium* is a component of the saline prairie flora. Though often conspicuous on pimple mounds, *S. scoparium* was not a dominant species of broad flats in our study sites. In our study sites, the most conspicuous grasses in broad flats, which accounted for the largest area of any landscape position, were *Aristida longespica*, *A. oligantha*, and *Sporobolus vaginiflorus* var. *vaginiflorus*. These species are fall-flowering annuals. They are widespread and occur in a variety of habitats including disturbed areas, dry fields, roadsides, and waste places (Grass Phylogeny Working Group and Allred 2003; Peterson et al. 2003). These species were conspicuous in undisturbed parts of our study sites. Perhaps these disturbance-tolerant species were abundant in our saline prairies because they are exploiting the available growing space provided by relatively sparse vegetative cover and taking advantage of seasonally exposed soil.

Table 3. Soil particle size distribution and organic matter (OM%) for each horizon of soil cores taken from broad flat, slick, and pimple mound landscape positions from Barron Road, Dalton/Dickson, and Upper Weyerhaeuser Saline Prairies in Louisiana.

Landscape Position	Site	Horizon	Depth (cm)	% Sand	% Silt	% Clay	Textural Class	Organic Matter (%)
Position	Site	Horizon	Depth (cm)	Sand	Silt	Clay	Class	Matter (%)
BROAD FLAT	Dalton/ Dickson	A	0–13	39.2	50.3	10.5	Silt Loam	2.76
		E1	13–25	27.3	47.9	24.8	Loam	2.97
		Btk1	25–46	26.1	44.7	29.2	Clay Loam	4.09
		Btkn/E1	46–79	22.6	45.8	31.6	Clay Loam	4.27
		Btkn/E2	79–104	30.3	43	26.7	Loam	3.43
		Btk	104–132	37.1	41.2	21.7	Loam	2.75
		BC	132–158	43.1	39.1	17.8	Loam	2.32
	Rambin Bayou	A	0–8	50.8	44.8	4.4	Sandy Loam	1.89
		E1	8–13	35.3	49.1	15.6	Loam	2.12
		Btn1	13–69	31.2	41	27.7	Clay Loam	3.42
		Btkn/E1	69–99	38.5	34.5	27	Loam/Clay Loam	2.87
		Btn/E2, BC	99–223	64.9	21.9	13.2	Sandy Loam	1.39
	Upper Weyerhaeuser	A	0–13	34	62.1	3.9	Silt Loam	2.01
		E1	13–25	31	61.5	7.5	Silt Loam	1.87
		Btn/E1	25–53	17.1	62.4	20.5	Silt Loam	2.75
		Btng/E1	53–86	20.7	55	24.3	Silt Loam	2.87
		Btng/E2	86–135	22.6	54.8	22.6	Silt Loam	2.65
		BCg	135–190	5.9	65	29.1	Silty Clay Loam	3.50
		Cg1	190–213	11.8	56.8	31.4	Silty Clay Loam	3.69
SLICK	Dalton/ Dickson	A	0–15	33.6	39.5	26.9	Loam	3.26
		Btn1	15–43	41.8	35.6	22.6	Loam	2.97
		Btgn/E1	43–81	61.3	25.7	13	Sandy Loam	1.95
		Btgn/E2	81–127	65.8	24.2	10	Sandy Loam	1.51
		2C	127–157	84	13.1	2.9	Loamy Sand	0.74
	Rambin Bayou	A and E1	0–36	24.5	50.6	24.9	Silt Loam	3.26
		Btkn/E1	36–101	22.7	45.3	32	Clay Loam	4.41
		2BC	101–152	53.3	28.8	17.9	Sandy Loam	2.53
		2C	152–218	67.3	19.9	12.8	Sandy Loam	1.57
	Upper Weyerhaeuser	A	0–8	15.7	70.2	14.1	Silt Loam	2.32
		BE	8–28	6.1	68.3	25.6	Silt Loam	3.53
		Btng/E1	28–51	5.1	71.2	23.7	Silt Loam	3.12
		Btng/E2	51–89	5.5	71.7	22.8	Silt Loam	2.95
		Btkng/E3	89–127	6.9	65.1	28	Silty Clay Loam	3.59
		Btkng/E4	127–160	9.1	58.4	32.5	Silty Clay Loam	3.78
PIMPLE MOUND	Dalton/ Dickson	A	0–15	57.6	37	5.4	Sandy Loam	2.82
		E1	15–46	53	41.1	5.9	Sandy Loam	1.87
		E2	46–61	53.4	40.7	5.9	Sandy Loam	1.50
		Bt/E1	61–84	53.5	43	3.5	Sandy Loam	0.91
		Bt/E2	84–119	49.3	43.9	6.8	Sandy Loam	0.88
		Btg1	119–157	44.9	38.4	16.7	Loam	1.85
	Rambin Bayou	A, E1, E2	0–23	54.2	42.1	3.7	Sandy Loam	2.37
		E3	23–48	48.5	49	2.5	Sandy Loam	0.75
		Btn1, Btn2	48–111	34.9	47	18.1	Loam	2.16
		Btn, E1	111–144	29.9	41.3	28.8	Clay Loam	3.49
		Btn/E2, BC	144–221	59.09	23.5	17.36	Sandy Loam	2.56

Table 4. Mehlic-extractable nutrients (Ca, Mg, Na), pH, cation exchange capacity (CEC), sodium adsorption ratio (SAR), and electrical conductivity (EC) for each horizon of soil cores taken from broad flat, slick, and pimple mound landscape positions from Barron Road, Dalton/Dickson, and Upper Weyerhaeuser Saline Prairies in Louisiana.

Landscape Position	Site	Horizon	Depth (cm)	Ca (mg kg⁻¹)	Mg (mg kg⁻¹)	Na (mg kg⁻¹)	pH (1:2)	CEC (cmol kg⁻¹)	SAR	EC (Saturated Paste) (mS cm⁻¹)	EC (1:2 soil:water) (mS cm⁻¹)
	Dalton/ Dickson	A	0–13	394.4	122.6	127.4	5.45	6.48	1.5	—	0.1
		E1	13–25	542.1	266.4	962.5	5.94	11.99	7.7	—	0.2
		Btk1	25–46	692.1	418.4	1779	6.02	18.04	12.1	—	0.3
		Btkn/E1	46–79	876.7	603.1	2548	8.08	20.38	18.1	—	0.3
B		Btkn/E2	79–104	703.1	551.2	2348.1	8.72	17.09	16.7	—	0.4
R		Btk	104–132	1016.8	471.4	1992	9.12	13.72	11.8	—	0.5
O		BC	132–158	1930.8	431	1755.6	9.26	12.54	9.2	—	0.6
A	Rambin Bayou	A	0–8	201.5	75.8	63.9	5.7	2.21	3.1	0.1	0.1
D		E1	8–13	208.8	108.8	1077.4	6.98	6.04	16.7	1	0.2
		Btn1	13–69	669.3	435.9	3305.3	9.41	16.75	43.8	2.2	0.7
		Btkn/E1	69–99	686.5	311.7	3407.7	9.65	15.99	53	2.3	0.8
		Btn/E2, BC	99–223	793.6	188.5	1546.1	9.62	8.49	14.2	Btn/E2 - 1.7 BC - 1.0	0.5
F	Upper Weyerhaeuser	A	0–13	245.8	78.5	121.8	6.88	2.39	1.6	0.7	0.1
L		E1	13–25	246.9	129.3	449.6	7.17	4.5	5.9	0.3	0.1
A		Btn/E1	25–53	362.9	301.1	1721.4	8.32	11.04	15.2	1.4	0.2
T		Btng/E1	53–86	414.7	366.7	2136.1	8.6	12.59	18.2	1.5	0.3
		Btng/E2	86–135	406.8	339.3	1961.3	8.57	12.4	16.8	1.4	0.2
		BCg	135–190	569	421.3	2403.2	8.71	17.97	20.6	1.4	0.3
		Cg1	190–213	668.4	454.4	2606.7	8.84	17.54	17.2	1.7	0.3
	Dalton/ Dickson	A	0–15	692.3	446.1	2425.1	8.51	16.3	21.4	—	0.3
		Btn1	15–43	487.6	349.5	2330.2	9.31	13.58	13.7	—	0.5
		Btgn/E1	43–81	812.2	213.9	1552.3	9.51	8.04	12.5	—	0.4
		Btgn/E2	81–127	198.8	121.3	1187.3	8.72	6.97	16.4	—	0.1
		2C	127–157	196.2	81	327.9	8.21	2.37	13.2	—	0
S	Rambin Bayou	A and E1	0–36	1115.8	377.1	2979.6	9.52	12.97	32.7	A – 1.2; E1 - 2.3	0.8
L		Btkn/E1	36–101	816.8	307.4	4557.2	9.71	19.33	96	2.4	0.8
I		2BC	101–152	464.7	141.9	2506.2	9.53	12.81	43.8	1.6	0.4
C		2C	152–218	620.8	159.1	1432.7	9.26	8.1	19.7	(sample too small)	0.2
K		A	0–8	429.3	270.1	844.2	6.41	7.83	7.6	0.6	0.3

Table 4. continued.

Landscape Position	Site	Horizon	Depth (cm)	Ca (mg kg^{-1})	Mg (mg kg^{-1})	Na (mg kg^{-1})	pH (1:2)	CEC (cmol kg^{-1})	SAR	EC (Saturated Paste) (mS cm^{-1})	EC (1:2 soil:water) (mS cm^{-1})
	Upper Weyerhaeuser	BE	8–28	691.9	558.3	2039.2	8.07	16.48	14.2	1.6	0.3
		Btng/E1	28–51	563.6	482	2054.7	8.73	15.53	15.6	1.4	0.3
		Btng/E2	51–89	483.3	406.3	2133.8	9.02	14.87	18.9	1.7	0.3
		Btkng/E3	89–127	764.5	404.9	2532.3	9.04	16.49	20.6	1.5	0.4
		Btkng/E4	127–160	1008.9	429.7	2765.4	8.95	19.01	21.7	1.6	0.6
PIMPLE	Dalton/ Dickson	A	0–15	157	33.6	15.9	4.85	4.34	0.5	—	0
		E1	15–46	76.8	21.5	6.6	4.48	3.03	0.5	—	0
		E2	46–61	63.6	20.5	12.4	4.71	2.75	1.1	—	0
		Bt/E1	61–84	52.5	19.6	19	5.2	1.4	2.1	—	0
		Bt/E2	84–119	53.9	50.7	263.9	6.27	2.07	8.7	—	0
		Btg1	119–157	92.3	115.5	782.9	6.08	6.99	14.9	—	0.1
MOUND	Rambin Bayou	A, E1, E2	0–23	309.9	23.4	15.9	4.78	2.75	4	—	0
		E3	23–48	63.7	22.6	47.3	5.62	0.71	8.8	—	0
		Btn1, Btn2	48–111	221.1	168.4	1790.4	8.41	8.33	24.4	—	0
		Btn, E1	111–144	312.7	279.2	3082.1	9.01	14.31	51.3	—	0
		Btn/E2, BC	144–221	624.383	217.532	2170.21	9.51	10.88	25.9	—	0

A conspicuous floristic component of saline prairies consists of late-winter and spring ephemerals that complete their reproductive cycle while there is adequate moisture. During winter and spring months, moisture is abundant in the upper soil horizons as rainfall is plentiful and evapotranspiration is low. These ephemeral species usually disappear by May or June (earlier in some cases). Examples of such species include *Anagallis minima*, *Crassula aquatica*, *Coreopsis tinctoria*, *Geocarpon minimum*, *Gratiola flava*, *Houstonia* spp., *Krigia dandelion*, *Krigia occidentalis*, *Minuartia drummondii*, *Minuartia muscorum*, *Phacelia glabra*, *Sabatia campestris*, *Schedonnardus paniculatus*, and *Scutellaria parvula*.

As the summer sets in, soils of the broad flats and slicks become drier and harder as water in the A and E horizons is depleted by evapotranspiration. Drought tolerant species such as *Iva angustifolia*, *Opuntia* sp., *Mirabilis albida*, and *Phemeranthus parviflorus* are often the only plants in broad flats and slicks that are in good condition during the hottest summer months.

The pimple mound flora includes species that would be expected in dry to sub-xeric sandy soils of pine or hardwood dominated woodlands elsewhere in the West Gulf Coastal Plain. Examples of such species include *Alophia drummondii*, *Andropogon ternarius*, *Digitaria cognata*, *Ilex vomitoria*, *Panicum brachyanthum*, *Quercus margaretta*, *Schizachyrium scoparium*, and *Vaccinium arboreum*. *Pinus taeda* seedlings and saplings were relatively frequent on pimple mounds of our study sites. Mature *P. taeda* were rare. Some seedling and sapling mortality was noted but the cause was not diagnosed. Drought stress is a possibility. Mature trees on pimple mounds were most frequently *Quercus margaretta*, and often these trees were of large diameter, short height, and were twisted and possibly very old.

The soil analyses confirmed the natric horizon characterizations previously described for both the Bonn and Brimstone soil series (Soil Survey Staff 2006; Soil Survey Staff 1998; Soil Survey Staff 1991; Soil Survey Staff 1980). Soil textural data from the extracted cores underscored the differences between landscape positions. Pimple mounds were notably sandier than the broad flats and slicks, while the silt component dominated the broad flat and slick cores (Table 3).

The surface horizons in our study sites, with the exception of slicks, were acidic with low SAR values (Table 4). Obligate halophytic species are lacking in our study sites. Based on personal observation at our study sites and elsewhere, *Sporobolus pyramidatus* could be considered halophytic. In our study areas it was restricted to and common on slicks. Peterson et al. (2003) report *S. pyramidatus* to occur in "disturbed soils, roadsides, railways, coastal sands, and alluvial slopes in many plant communities." *Iva angustifolia* is a very conspicuous herb on broad flats. Habitat accounts for *Iva angustifolia* by Gandhi and Thomas (1989) and Strother (2006) indicate that it grows in disturbed areas, waste places, and overgrazed pastures, with no mention of saline or natric soils. Since this species colonizes areas impacted by oilfield brine (personal observation), it might be considered a facultative halophyte. It appears that the vegetation of saline prairies is largely controlled by the influence of the natric subsurface horizons on soil moisture content and availability, rather than chemical characteristics in the plant rooting zone.

The community name "saline prairie" has been used by Louisiana Natural Heritage Program (2009b), Keith et al. (2004), Lester et al. (2005), MacRoberts et al. (2009a) and McInnis et al. (1993), among others. Saline soils have high levels of dissolved salts, the concentration of which is measured by electrical conductivity (Hassett & Banwart 1992). Natric soils do not have excessive concentrations of dissolved salts but rather have high concentrations of exchangeable Na. While salinity will negatively impact sensitive plants, the adverse physical characteristics of natric soils are not necessarily present in saline soils (Hassett & Banwart 1992). The sodium adsorption ratio (SAR) is considered the standard measure of soil sodicity (Soil Survey Staff 1993). This ratio also takes into account the comparative concentrations of calcium and magnesium ions that tend to moderate the adverse effects of Na. Sodium adsorption ratio values above 12 to 15, combined with alkaline pH, identify a natric horizon (Table 4). For many subsurface horizons from our broad flat and slick cores, SAR values exceed the threshold range, and in some cases, greatly so (Table 4). Depending on texture, natric soils can become extremely sticky when wet and almost impermeable to surface water. When dry they can be very hard and resist wetting. In both cases, plants will have difficulty obtaining soil water. Our analysis of soil cores for saturated paste EC shows that a few subsurface horizons from one site are very slightly saline according to Soil Survey Staff (1993) and soils at the other study site are completely non-saline. Hassett and Banwart (1992) consider soils to be saline if EC is 4 mS/cm or higher, well above EC values in our data. Thus, applying the term "saline" to the natural community name may be misleading. Arkansas Multi-Agency Wetland Planning Team (2001) avoids this inaccuracy by applying the name "Alkali Flat," which accounts for the natric soils and generally flat topography.

The floristics and edaphic traits of saline prairies are the principal factors that define these natural community systems. Based on the International Vegetation Classification (IVC) system, NatureServe (2009) places saline prairies and the associated saline oak woodlands within the South-Central Saline Glade ecosystem (CES203.291). This glade ecosystem is broken down into several vegetation associations with four prairie associations and one woodland association known from Louisiana. The most frequently identified association in Louisiana is the *Artistida longespica* Poir. – *Schizachyrium scoparium* – *Diodia teres* Saline Herbaceous Vegetation (CEGL008419), and it seems to be most closely matching association for saline prairies in northwest Louisiana. This association was described based principally on saline prairies in Arkansas, and therefore some differences in plant species occur for the Louisiana prairies. For example, *Schizachyrium scoparium*, *Diodia teres*, and *Sabal minor* while present, are not dominants in Louisiana examples we have studied.

The historical role of fire in saline prairies is not known. Sparse vegetative cover may have reduced the role of fire in these systems (NatureServe 2009). Extreme soil properties and droughty conditions are apparently sufficient to maintain prairies in our study sites, which have no threat of woody encroachment. While prairies studied by us appear to be edaphically extreme enough to prevent woody encroachment and to maintain a grassland community, fire may have been very important in adjacent communities and thus important in a broader landscape context.

Studies of floristics and edaphics of additional saline prairies throughout the range of the community would expand information on geographic variation and enable refinement of the natural community classification. Quantitative sampling of vegetation and edaphic variables in random or systematically placed plots would enable correlations of vegetation to soils on a fine scale. This type of procedure may reveal important factors determining the vegetation composition, density, and coverage in saline prairies that are not apparent with our broader floristic approach.

There is a wet-variant saline prairie that is sometimes adjacent to the saline prairie community described in this paper (Louisiana Natural Heritage Program 2009b). These prairies occur on lower landscape positions, experience regular inundation, and support halophytes more characteristic of coastal localities such as *Atriplex cristata* Humb. & Bonpl. ex Willd., *Distichlis spicata* (L.) Greene, *Heliotropium curassavicum* L., and *Solidago sempervirens* L. (Smith 1996). In Louisiana, *Spartina pectinata* Bosc ex Link is almost entirely restricted to wet-variant saline prairies. Wet-variant saline prairies are in need of similar baseline floristic and edaphic study.

APPENDIX 1. CHECKLIST OF SPECIES

Species recorded from Barron Road Saline Prairie (B) and Dalton/Dickson Saline Prairie (D). Key to voucher specimens: CR = Christopher Reid, whose specimens are deposited at LSU; MM = B.R. and M.H. MacRoberts, whose specimens are deposited at LSU and LSUS. If there is no mention of landscape position, broad flats is intended. Species of slicks are treated as occurring in broad flats in this list. Table 1 lists characteristic species of each landscape position, including slicks. Rare species are denoted with a dagger (†). State- or globally-rare species are summarized in Table 2, where conservation status ranks are provided. Exotic species are denoted with an asterisk (*).

Acanthaceae

Justicia ovata (Walt.) Lindau var. *lanceolata* (Chapm.) R. W. Long—D, wet depressions, MM 7816

Ruellia humilis Nutt.—B D, broad flats and pimple mounds, CR 5931, MM 7245, 7447, 7954

Alismataceae

Sagittaria papillosa Buchenau—D, wet depressions, MM 7728, 7887

Alliaceae

Allium canadense L. var. *mobilense* (Regel) M. Ownbey—B D, MM 7354, 7384 (observed but not collected at D)

Nothoscordum bivalve (L.) Britt.—B D, MM 7292, 7604

Amaryllidaceae

†*Cooperia drummondii* Herbert—B D, CR 5655, MM 7247 (observed but not collected at D)

Habranthus tubispathus (L'Hér.) Traub—B D, CR 5598, MM 7246 (observed but not collected at D)

Anacardiaceae

Rhus copallinum L.—B, pimple mounds, MM 7260

Apiaceae

Daucus pusillus Michx.—D, pimple mounds, CR 7001

Limnosciadium pinnatum (DC.) Mathias & Constance—B D, broad flats and wet depressions, CR 6129, 6982, MM 7403, 7414, 7421, 7749, 7774, 7799

Ptilimnium nuttallii (DC.) Britt.—B D, pimple mounds, broad flats, and wet depressions, CR 6174, MM 7422, 7444, 7800

Trepocarpus aethusae Nutt. ex DC.—B, MM 7440

Aquifoliaceae

Ilex vomitoria Ait.—B, pimple mounds, CR 7199, MM 7261

Aracaceae

Sabal minor (Jacq.) Pers.—D, broad flats and wet depressions, CR 6180, MM 7355, 7947

Aspleniaceae

Asplenium platyneuron (L.) B.S.P.—D, pimple mounds, CR 6994

Asteraceae

Baccharis halimifolia L.—B D, wet depressions and pimple mounds, MM 7270 (observed but not collected at D)

Boltonia diffusa Ell.—B, MM 7436

Chrysopsis pilosa Nutt.—B D, pimple mounds, MM 7450, 7818, 7875

Coreopsis lanceolata L.—D, broad flats edges (upslope), CR 6986

Coreopsis tinctoria Nutt.—B D, CR 6065, MM 7407, 7797, 7750

†*Diaperia verna* (Raf.) Morefield (= *Evax verna* Raf.)—D, CR 6077

Erigeron tenuis Torr. & A. Gray—B D, CR 6996, MM 7337, 7383

Euthamia leptocephala (Torr. & A. Gray) Greene—B D, CR 5926, MM 7464

**Facelis retusa* (Lam.) Sch. Bip.—D, pimple mounds, MM 7617

Gamochaeta argyrinea Nesom—B, MM 7433

Helenium flexuosum Raf.—B D, wet broad flats, CR 7019, MM, 7419

Iva angustifolia Nutt. ex DC.—B D, CR 5661, 5925, MM 7404, 7463, 7939, 8047

Iva annua L.—D, CR 6750, MM 7870, 8048

Krigia dandelion (L.) Nutt.—B D, MM 7299, 7328 (observed but not collected at D)

Krigia occidentalis Nutt.—B D, CR 6005, MM 7300, 7598

Liatris aspera Michx.—D, pimple mounds, CR 5835

Marshallia caespitosa Nutt. ex DC.—B D, pimple mounds, CR 5723, 6988, MM 7351, 7378

†*Pterocaulon virgatum* (L.) DC.—D, pimple mounds, CR 5927

Pyrrhopappus carolinianus (Walt.) DC.—B D, CR 7018, MM 7416

Symphyotricum pratense (Raf.) Nesom—B, MM 7283

Brassicaceae

Lepidium densiflorum Schrad.—D, CR 6124, MM 7754

Lepidium virginicum L.—B D, MM 7326, 7334, 7379, 7606

Buddlejaceae

Polypremum procumbens L.—D, pimple mounds, MM 8050

Cactaceae

Opuntia Mill. sp.—B D, CR s.n., MM 7396, 7768 (Note: species identification in our *Opuntia* material is premature and warrants further systematic study [L. Majure, pers. comm.])

Callitrichaceae

Callitriche peduncolosa Nutt. (=*C. nuttallii* Torr.)—B, MM 7306

Campanculaceae

Lobelia appendiculata A. DC.—B D, pimple mounds, CR 7000, MM 7400

Triodanis perfoliata (L.) Nieuwl.—B D, CR 5734, MM 7350, 7380, 7746

Caryophyllaceae

**Cerastium glomeratum* Thuill.—B D, MM 7323, 7335, 7605

†*Geocarpon minimum* Mackenzie—B D, CR 5995, 6003, MM 7284, 7585

†*Minuartia drummondii* (Shinners) McNeill—B D, CR 5721, MM 7308, 7586, 7615

†*Minuartia muscorum* (Fassett) Rabeler—B D, CR 5712, 5720, 6013, MM 7309, 7317, 7331, 7612, 7723

Cistaceae

†*Helianthemum rosmarinifolium* Pursh—B D, pimple mounds, CR 5770, 5776, MM 7431, 7401, 7739, 7804

†*Lechea san-sabeana* (Buckley) Hodgdon—B D, pimple mounds, CR 6064 (TEX-LL), 6179, MM 7738, 7824, 7827, 7828, 7832, 7834

Lechea tenuifolia Michx.—B D, broad flats and pimple mounds, CR 6176, MM 7829, 7822, 7823, 7951

Clusiaceae

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray—B D, CR 5662, 6126, MM 7250, 7462, 7356, 7446, 8052

Hypericum gentianoides (L.) B.S.P.—D, MM 7874

Hypericum hypericoides (L.) Crantz—B, pimple mounds, MM 7262

Commelinaceae

Tradescantia hirsutiflora Bush—B D, broad flats and pimple mounds, CR 7016, MM 7348, 7602, 7730

Tradescantia occidentalis (Britt.) Smyth—B D, CR 6075, MM 7346, 7347, 7755, 7603

Convolvulaceae

Dichondra carolinense Michx.—D, pimple mounds, CR 6995

Evolvulus sericeus Sw.—B D, CR 5658, 6135, MM 7279, 7376, 7753

Crassulaceae
Crassula aquatica (L.) Schoenl.—B D, CR 5996, MM 7303, 7589

Cupressaceae
Juniperus virginiana L.—D, pimple mounds, CR 5781, MM 8121, 7760

Cuscutaceae
Cuscuta gronovii Willd. ex Schult.—D, CR 5923, MM 8053

Cyperaceae
†*Carex arkansana* Bailey—D, wet depressions, CR 5748
Carex bushii Mack.—B, MM 7389
Carex complanata Torr. & Hook.—D, pimple mounds, CR 7017
Carex crus-corvi Shuttleworth ex Kunze—D, wet broad flats, CR 5766
Carex lupulina Muhl. ex Willd.—D, wet broad flats, CR 5765
Cyperus acuminatus Torr. & Hook. ex Torr.—B D, wet depressions and pimple mounds MM 7434, 7767, 7889
Cyperus echinatus (L.) Alph. Wood—D, MM 7885 (mixed sheet with *C. retroflexus*)
Cyperus pseudovegetus Steud.—D, wet depressions, CR 7014, MM 7811, 7770
Cyperus retroflexus Buckley—D, MM 7885 (mixed sheet with *C. echinatus*)
Cyperus retrorsus Chapm.—D, wet depressions, pimple mounds, and broad flats, CR 6144, MM 7812, 7892, 7958
Cyperus squarrosus L. (=*C. aristatus* Rottb.)—D, MM 7955
Cyperus strigosus L.—D, broad flats edges, CR 7193
Eleocharis tenuis (Willd.) Schult. var. *verricosa* (Svenson) Svenson—B, MM 7338
Eleocharis ambigens Fernald—D, wet depressions, MM 7765, 7772
†*Eleocharis wolfii* (A. Gray) A. Gray ex Britt.—B D, wet depressions, CR 6080, 6083, 6980, 6981, MM 7722
Fimbristylis puberula (Michx.) Vahl—B D, CR 6128, 6140, MM 7256, 7305, 7320, 7388, 7743, 7744, 7798
Isolepis carinata Hook. & Arn. ex Torr.—B D, MM 7297, 7597
Rhynchospora corniculata (Lam.) A. Gray—D, wet depressions, MM 7776, 7880
Rhynchospora caduca Ell.—D, wet depressions, CR 5779
Rhynchospora globularis (Chapm.) Small var. *globularis*—B D, pimple mounds and wet depressions, CR 6137, MM 7724, 7428
Rhynchospora harveyi W. Boott—B D, pimple mounds, CR 5596, 5739, 6177, 7024, MM 7427
Scleria ciliata Michx.—B D, CR 5777, MM 7395

Ericaceae
Vaccinium arboreum Marsh.—B D, pimple mounds, CR 6130, MM 7263, 7758, 8118

Euphorbiaceae
Acalypha gracilens A. Gray—D, pimple mounds, CR 5922
Chamaesyce maculata (L.) Small—D, MM 7945
Croton capitatus Michx.—B D, broad flats and pimple mounds, CR 6751, MM 7448, 7868
Croton willdenowii G.L.Webster—B D, broad flats and pimple mounds, CR s.n., 5666, 6757, MM 7267, 7449, 7807, 7881
Euphorbia spathulata Lam.—B D, MM 7382 (observed but not collected at D)

Fabaceae
Astragalus distortus Torr. & A. Gray var. *engelmannii* (E. Sheld.) M.E. Jones—B D, CR 6002, MM 7289, 7599
Chamaecrista fasciculata (Michx.) Greene—B D, broad flats and pimple mounds, CR 5775, MM 7282, 7795, 7432
Gleditsia triacanthos L.—D, MM 7442, 7759
Kummerowia striata (Thunb.) Schindl.—D, pimple mounds, MM 7946
Lathyrus pusillus Ell.—B D, CR 6926, MM 7333
Lespedeza repens (L.) Bart.—D, pimple mounds, CR 5778
†*Lotus unifoliolatus* (Hook.) Benth.—B, MM 7373, 7397
Medicago lupulina L.—D, MM 7601
Mimosa strigillosa Torr. & A. Gray—B D, MM 7257, 7949
Neptunia lutea (Leavenworth) Benth.—B D, CR 5758, MM 7249, 7735, 7796
Strophostyles leiosperma (Torr. & A. Gray) Piper—D, broad flats and pimple mounds, CR 6175, MM 7802, 7886, 7820

Fagaceae
Quercus margaretta Ashe—B D, pimple mounds, CR 6756, 7194, 7196, MM 7258
Quercus phellos L.—B, pimple mounds, MM 7248
Quercus similis Ashe—D, CR 6136, 7025, 7195, 7197, 7200
Quercus stellata Wang.—D, broad flats and pimple mounds, MM 7763

Gentianaceae
Sabatia campestris Nutt.—B D, CR 6127, MM 7415, 7742, 7805, 7806

Grossulariaceae
†*Ribes curvatum* Small—D, pimple mounds, CR 6016

Haloragaceae
Myriophyllum pinnatum (Walt.) B.S.P.—D, wet depressions, CR 7026, MM 7737, 7877

Hyacinthaceae
†*Schoenolirion wrightii* Sherman—B D, CR 5693, 5715, MM 7291, 7315, 7343, 7398, 7595

Hydrophyllaceae
†*Phacelia glabra* Nutt.—B D, broad flats and pimple mounds, CR 5692, 5722, MM 7327, 7607

Iridaceae
Alophia drummondii (Graham) R.C. Foster—D, pimple mounds, CR 7012
Sisyrinchium atlanticum E. P. Bicknell—D, MM 7726
Sisyrinchium langloisii Greene—B, MM 7329, 7330
Sisyrinchium rosulatum E. P. Bicknell—B D, CR 6989, MM 7344

Isoetaceae
Isoetes melanopoda Gay & Durieu ex Durieu—B D, wet depressions, MM 7293, 8496

Juncaceae
Juncus acuminatus Michx.—D, wet depressions, CR 5763, 5768, 6139, 7013, MM 7775

Juncus brachycarpus Engelm.—B D, wet broad flats, CR 5773, MM 7394, 7424

*_Juncus capitatus_ Weigel—D, broad flats and pimple mounds, CR 7022, MM 7594

Juncus dudleyi Wiegand—B D, wet depressions, CR 5738, 5772, MM 7409, 7766

Juncus dichotomus Elliott—B D, wet broad flats, CR 7015, MM 7387

Juncus marginatus Rostk.—D, pimple mounds and wet broad flats, CR 5762, 5774, 7004, 7021, MM 7809

Juncus secundus P. Beauv. ex Poir.—D, wet broad flats, CR 7020

Luzula bulbosa (Alph. Wood) Smyth & Smyth—B D, broad flats and pimple mounds, CR 5714, MM 7319, 7608

Lamiaceae

Hedeoma hispida Pursh—B D, CR 6066, MM 7352, 7377, 7748, 7944

Physostegia intermedia (Nutt.) Engelm. & A. Gray—D, wet depressions, CR 5735, MM 7769

Prunella vulgaris L.—D, broad flats edges, CR 6987

Scutellaria integrifolia L.—B, pimple mounds, MM 7399

Scutellaria parvula Michx.—B, pimple mounds, MM 7324

Linaceae

Linum medium (Planch.) Britt. var. _texanum_ (Planch.) Fern.—B D, broad flats and pimple mounds, CR 5740, MM 7412, 7425, 7808

Loganiacaeae

Gelsemium sempervirens (L.) St.-Hil.—B, pimple mounds, MM 7290

Lythraceae

Ammania coccinea Rottb.—D, wet depressions, MM 7810, 7941

Nyctaginaceae

†_Mirabilis alba_ (Walt.) Heimerl—D, CR 5742, 5832, 5924, 6754

Oleaceae

†_Forestiera ligustrina_ (Michx.) Poir.—D, pimple mounds, CR 5991, 6131, 7204

Fraxinus pennsylvanica Marsh.—D, pimple mounds, MM 7762

*_Ligustrum sinense_ Lour.—D, pimple mounds, CR 7201

Onagraceae

Ludwigia alternifolia L.—D, wet depressions, MM 7817

Ludwigia glandulosa Walt.—D, wet depressions, CR 5760

Ludwigia peploides (Kunth) Raven—D, wet depressions, MM 7878, 7948

Oenothera laciniata Hill—D, MM 7741, 7803

Oenothera linifolia Nutt.—B D, CR 6068, MM 7353, 7616, 7745

Oenothera spachiana Torr. & A. Gray.—D, CR 6015, 6072, 6067

Ophioglossaceae

Botrychium lunarioides (Michx.) Sw.—D, CR 6925

Orchidaceae

Spiranthes vernalis Engelm. & A. Gray—B, MM 7435, 7430

Oxalidaceae

Oxalis corniculata L.—D, MM 7609, 7813

Oxalis dillenii Jacq.—B, MM 7336

Pinaceae

Pinus echinata Mill.—D, pimple mounds, MM 7814

Pinus taeda L.—B D, pimple mounds, MM 7265, 7761, 7815 (observed but not collected at D)

Plantaginaceae

Plantago aristata Michx.—B D, CR 6141, 7023, MM 7405, 7740, 7752

Plantago pusilla Nutt.—B D, MM 7301, 7332, 7611

Plantago virginica L.—B D, CR 6997, MM 7302, 7393

Poaceae

Agrostis elliottiana Schult.—B D, CR 5718, MM 7325, 7596

Agrostis hyemalis (Walt.) B.S.P.—B D, CR 5771, MM 7418

*_Aira caryophyllea_ L.—D, CR 5743, MM 7593

*_Aira elegans_ Willd.—D, CR 6014, MM 7729

Andropogon ternarius Michx.—D, broad flats and pimple mounds, CR 5983, MM 7884, 7950, 8044, 8120

Aristida longespica Poir.—B D, CR 5645, 5648, 5649, 5650, 5652, 5988, 5657; MM 7274

Aristida oligantha Michx.—B D, CR 5651, 5989, MM 7251, 7940, 8119

*_Briza minor_ L.—B D, CR 6134, MM 7349, 7747

*_Bromus racemosus_ L.—D, broad flats edges, CR 6983

*_Cynodon dactylon_ (L.) Pers.—B D, CR 6178, MM 7385, 7757

Dichanthelium aciculare (Desv. ex Poir.) Gould and C.A. Clark—B D, CR 5716, 5737, MM 7391, 7392, 7402

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark subsp. _lindheimeri_ (Nash) Freckmann & Lelong—D, CR 6071

Dichanthelium dichotomum (L.) Gould & C.A. Clark ssp. _roanokense_ (Ashe) Freckmann & Lelong—B, MM 7420, 7406

Dichanthelium oligosanthes (Schultes) Gould ssp. _oligosanthes_—D, CR 5744

Dichanthelium scoparium (Lam.) Gould—B D, MM 7438 (observed but not collected at D)

Dichanthelium sphaerocarpon (Ell.) Gould var. _sphaerocarpon_—B D, broad flats and pimple mounds, CR 5736, MM 7252

Digitaria cognata (J.A. Schultes) Pilger—B D, pimple mounds, CR 5647, 5834, 6761, MM 7281

Eragrostis lugens Nees—B D, CR 5646, 6753, MM 7253

Eragrostis secundiflora J. Presl.—D, CR 5833, 5984, 6762, MM 7882, 8045

Hordeum pusillum Nutt.—B D, CR 6081, MM 7390, 7732

*_Lolium perenne_ L.—D, CR 6985, MM 7756

Panicum brachyanthum Steud.—D, pimple mounds, CR 5831, MM 8049

Paspalum floridanum Michx.—D, pimple mounds, CR 7198

Paspalum setaceum Michx.—B D, CR 5653, 6759, MM 7280, 7423

Phalaris caroliniana Walt.—B D, broad flats and pimple mounds, CR 6078, MM 7374, 7731

†_Schedonnardus paniculatus_ (Nutt.) Trel.—D, CR 5747, MM 7411, 7872

Schizachyrium scoparium (Michx.) Nash—B D, broad flats and pimple mounds, CR 5990, MM 7271, 8051
Setaria parviflora (Poir.) Kerguélen—B D, CR 6758, MM 7266, 7952
**Setaria pumila* (Poir.) Roem. & Schult. subsp. *pallidefusca* (Shumach.) B.K. Simon—B, MM 7443
Sphenopholis filiformis (Chapm.) Scribn.—D, CR 6079
Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi—D, pimple mounds, CR 5932, 6752, 6760
**Sporobolus indicus* (L.) R. Br.—D, CR 5759
Sporobolus pyramidatus (Lam.) A.S. Hitchc.—B D, CR 5654, 5660, 5780, 5928, 6125, MM 7277, 7437, 7873
Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood. var. *vaginiflorus*—B D, CR 5659, 5987, MM 7272
Steinchisma hians (Ell.) Nash—B D, broad flats and wet depressions, CR 6138, MM 7268, 7254, 7773, 7888, 7956
Tridens flavus (L.) Hitchc. var. *flavus*—D, broad flats edges, CR 6755
Tridens strictus (Nutt.) Nash—B D, wet depressions, CR 5985, MM 7269, 7891, 7942
Urochloa platyphylla (Munro ex C. Wright) R. D. Webster—B D, MM 7275 (observed but not collected at D)
Vulpia octoflora (Walt.) Rydb.—D, CR 6133, 6998

Polygonaceae
**Polygonum aviculare* L.—B, CR 5665
Polygonum hydropiperoides Michx.—D, wet depressions, CR 5761, MM 7771, 7871
Polygonum ramosissimum Michx.—B D, MM 7445, 7821, 7876
Rumex hastatulus Baldw.—B D, CR 5717, 6143, MM 7298, 7592

Portulacaceae
Claytonia virginica L.—B D, CR 5997, MM 7294, 7610
†*Phemeranthus parviflorus* (Nutt.) Kiger (= *Talinum parviflorum* Nutt.)—B D, CR 5593, 5725, MM 7255, 7278, 7413, 7751

Potamogetonaceae
Potamogeton diversifolius Raf.—D, wet depressions, MM 7736

Primulaceae
Anagallis minima (L.) Krause—B D, MM 7307 (observed but not collected at D)

Ranunculaceae
Anemone caroliniana Walt.—D, CR 5998
Delphinium carolinianum Walt.—D, pimple mounds, CR 6992
Ranunculus fascicularis Muhl. ex Bigelow—D, pimple mounds, MM 7590
**Ranunculus sardous* Crantz—B D, CR 6991, MM 7318

Rosaceae
Rubus louisianus Berger (= *R. argutus* Link)—B, pimple mounds, MM 7372
Rubus trivialis Michx.—B, pimple mounds, MM 7426

Rubiaceae
Diodia teres Walt.—B D, CR 5662, MM 7801, 7869, 7943
Galium tinctorium (L.) Scop.—B, MM 7345, 7386
Houstonia micrantha (Shinners) Terrell—B D, CR 5999, MM 7288, 7614
Houstonia pusilla Schoepf—B D, MM 7286, 7617b
Houstonia rosea (Raf.) Terrell—B D, CR 6000, MM 7287

Rutaceae
Zanthoxylum clava-herculis L.—D, pimple mounds, CR 7202, MM 7727

Sapotaceae
Sideroxylon lanuginosum Michx.—B D, broad flats and pimple mounds, CR 6142, MM 7264, 7591, 7725

Saxifragaceae
Lepuropetalon spathulatum Ell.—B D, MM 7304 (observed but not collected at D)
†*Saxifraga texana* Buckley—D, CR 6001, MM 8123

Scrophulariaceae
Agalinis heterophylla (Nutt.) Small ex Britt.—D, MM 8046
†*Gratiola flava* Leavenworth—B D, CR 5724, 6004, 6009, MM 7285, 7312, 7584
Gratiola virginiana L.—D, wet depressions, MM 7733
Nuttallanthus canadensis (L.) D. A. Sutton—B D, CR 6082, 6993, MM 7295, MM 7600

Smilacaceae
Smilax rotundifolia L.—B, pimple mounds, MM 7276

Solanaceae
Solanum carolinense L.—B, pimple mounds, MM 7417

Ulmaceae
Ulmus alata Michx.—B D, pimple mounds, CR 6132, 7203, MM 7259
Ulmus crassifolia Nutt.—D, pimple mounds, MM 7764

Valerianaceae
Valerianella radiata (L.) Dufr.—B D, CR 6076, MM 7321, 7322, 7613

Verbenaceae
Verbena halei Small—D, CR 6999, MM 7819, 7879

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BOOK REVIEW

Allan E. Bessette, David B. Harris, and Arleen R. Bessette. 2009. **Milk Mushrooms of North America: A Field Identification Guide to the Genus *Lactarius*.** (ISBN 978-0-8156-3229-0, hbk., alk. paper). Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, New York 13244-5290, U.S.A. (**Orders:** supress@syr.edu, 1-800-848-6224, 315-443-5545 fax). $110.00, 256 pp., 263 color illustrations, glossary, index, 7" × 10".

The authors have published mushroom books in the past and the organization, layout, color images, and descriptions are outstanding and illustrate the exceptional quality of the text. This book will appeal to a broad spectrum of mycophiles. The bright red hardback cover will be conspicuous in the field, but the larger-sized format also removes the book from the more conveniently hand-carried pocket-sized version. Fortunately the binding ensures a sturdy book that will stand the test of time and the wear and tear of fieldwork.

The genus *Lactarius*, also commonly called milk mushrooms because of lactifers that produce milky exudates of different colors when gills are bruised, has more than 200 species in North America and is widespread ectomycorrhizal in mostly forested areas. There are some highly prized edibles in this genus such as *Lactarius deliciosus* and *L. volemus*, but the majority of the species considered fall in the "unknown edibility" category. Although there is a clear warning about the dangers of eating mushrooms in the front of the book, this genus does not have the deadly poisonous toxins found in some other gilled-fungi such as the genus *Amanita*.

Most of the macro-morphological characters are discussed in the introduction such as size, shape, color, and characteristics of the cap, stalk, gills, odor (sometimes quite distinctive), taste, spore deposit color, habitat, and macrochemical tests. The color of the latex along with color changes over time when the latex stains the gills are also important key macro characteristics. Microscopic characteristics include descriptions of spore size and ornamentation (five scanning electron micrographs show the variety of spore ornamentation), spores amyloid or nonamyloid, cap cuticle, and cystidia.

Descriptions for 227 species and varieties are given along with a series of keys that are organized by regions. There is a "Regional Key to *Lactarius* Species and Their Relatives" that divides major groups into eastern and western species. The dichotomous diagnostic keys are based on macro-morphological characteristics that should facilitate use by beginners. The key couplets are nonreversible so that in longer keys (nine pages and 47 couplets) it is more difficult to follow through all of the choices especially when ending with three or four choices. However, some taxa are double-keyed, increasing the chance of correct identification as the reader is directed to the species or variety. The page number along with the species name aids in quickly locating the species in the text.

Pages 54 to 139 have three high quality color images per page (2 3/4" × 4 3/8") that show the top and side views of caps, gills, and stalks. "Species and Varieties: Descriptions" (pp. 141–274) are organized as follows: cap, gills, stalk, flesh, latex, spore deposit, microscopic characters, occurrence, edibility, and comments. There is a section on "Genera and Species Related to *Lactarius*" that includes the underground genus *Zelleromyces*, the pore bearing *Bondarzewia*, and *Arcangeliella*.

A special section titled "Hyperparasites of the Genus *Lactarius*" features the Lobster Mushroom, *Hypomyces lactifluorum*, which is a choice edible. The bright reddish orange coloration is actually an ascomycetous parasite of the genus *Hypomyces* that attacks and covers the surface area of a deformed *Lactarius* species.

The book ends with a "Glossary of Terms" (pp. 279–282), "References" (pp. 285–287), and "Index to Common and Scientific Names" (pp. 289–294). Mycologists doing fieldwork on fleshy macrofungi will find this book useful since species of *Lactarius* are frequently encountered throughout the summer growing season.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

FLORISTIC COMPOSITION AND POTENTIAL COMPETITORS IN *LINDERA MELISSIFOLIA* (LAURACEAE) COLONIES IN MISSISSIPPI WITH REFERENCE TO HYDROLOGIC REGIME

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ABSTRACT

Lindera melissifolia is a federally endangered shrub endemic to the southeastern United States. Hydrologic regime and floristic composition within individual *L. melissifolia* colonies in three disjunct populations in Mississippi were monitored for three years. Sixty-nine vascular plant species were identified growing within *L. melissifolia* colonies. Although number of flooding events and flood duration varied among the three populations, floristic composition and the ratio of *L. melissifolia* to other plants in the colonies remained relatively constant during the study period. In Mississippi, *Smilax* spp. and *Vitis* spp. have the greatest potential to become strong competitors of *L. melissifolia*.

RESUMEN

Lindera melissifolia es un arbusto en peligro a nivel federal, endémico del sureste de los Estados Unidos. Se monitorizó durante tres años el régimen hidrológico y la composición florística en colonias individuales de *L. melissifolia* en tres poblaciones disyuntas en Mississippi. Se identificaron sesenta y nueve especies de plantas vasculares creciendo en las colonias de *L. melissifolia*. Aunque el número de episodios de inundación y la duración de las inundaciones varió entre las tres poblaciones, la composición florística y la proporción de *L. melissifolia* con otras plantas de las colonias permaneció relativamente constante durante el periodo de estudio. En Mississippi, *Smilax* spp. y *Vitis* spp. tienen el mayor potencial para ser fuertes competidores de *L. melissifolia*.

INTRODUCTION

The Species

Lindera melissifolia (Walter) Blume is a dioecious shrub endemic to the southeastern United States. This member of Lauraceae, commonly called pondberry, was collected in South Carolina and described by Walter (1788) as *Laurus melissaefolia*. By the mid-20th century, Steyermark (1949) found that few herbarium specimens had been collected subsequent to Walter's (1788) description, with only three collections having been made in the first half of the twentieth century. Herbarium studies by Steyermark (1949) throughout the United States confirmed the historical presence of *L. melissifolia* in Alabama, Florida, Georgia, Louisiana, Missouri, North Carolina, and South Carolina. Although Gattinger (1901) made reference to *L. melissifolia* in Tennessee, Steyermark (1949) believed this report probably referred "...to misidentified pubescent *Lindera Benzoin*, since no authentic material of *L. melissaefolia* has been found in the herbarium of the University of Tennessee... ." Similarly, Deam (1924) excluded *L. melissifolia* from "Shrubs of Indiana" citing only one historic report with no voucher specimen. Based on the number of preserved *L. melissifolia*, Steyermark (1949) concluded that this species may be one of the rarest shrubs in the United States.

Currently, extant populations of *L. melissifolia* are present in Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina. It is believed to be extirpated in Louisiana and Florida. In the southeastern Coastal Plain (South Carolina and Georgia), *L. melissifolia* grows along the margin of seasonally flooded depressional wetlands dominated by *Nyssa biflora* Walter and *Taxodium ascendens* Brongn. (Aleric & Kirkman 2005). The only population known to occur in Alabama grows along the edge of a forested depres-

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sion under a partially open canopy of *N. biflora*, *Ilex myrtifolia* Walter, and *Quercus laurifolia* Michx. (Shotz 2005). In the Lower Mississippi Alluvial Valley (LMAV), *L. melissifolia* populations in Mississippi, Arkansas, and Missouri grow in periodically flooded, bottomland hardwood forests underlain by hydric soils. Forest canopy composition among the sites in the LMAV is similar, composed primarily of trees designated as facultative wetland or obligate wetland species (Hawkins et al. 2009a). *Liquidambar styraciflua*, *Acer rubrum*, *Q. lyrata*, *Q. nuttallii*, and *Q. phellos* are important canopy components; however, the relative importance of these and other canopy species varies between sites (Hawkins et al. 2009a).

Lindera melissifolia populations consist of spatially segregated, unisexual colonies (Hawkins et al. 2009b). Colony sizes range from approximately 20 stems to >1,000 stems (Morris 1987; Devall et al. 2001; Hawkins pers. obs.). In the LMAV, populations are strongly male-biased, with male to female colony ratios ranging from 7:1 (Wright 1994) to 19:1 (Hawkins et al. 2009b).

In both male (pollen-bearing) and female (seed/fruit-bearing) *L. melissifolia*, anthesis occurs in late spring, often during flooded conditions, and precedes leafing out. Small, yellow flowers are produced on axillary inflorescences (Fig. 1A), followed by production of green drupes on female plants. Approximately 90 days following anthesis, drupes contain a single, fully developed seed (Connor et al. 2007) and upon maturation drupes are bright red (Fig. 1B, 1C). Drupes are dispersed from fall to early winter (Smith et al. 2004) and fruit pedicels may remain on the plant until the following spring. Female *L. melissifolia* appear to invest heavily in sexual reproduction (Connor et al. 2007); however, seedlings are rarely observed in naturally occurring populations (Wright 1990). Vegetative propagation of ramets from rhizomes appears to be the predominant form of reproduction (Wright 1990, 1994).

During the first one to three years following seedling and/or ramet emergence, *L. melissifolia* plants are morphologically very similar to *L. benzoin* (L.) Blume. In fact, during Steyermark's (1949) investigation of the species, he noted numerous misidentified herbarium specimens of *L. melissifolia* resulting from this close similarity. Although leaf pubescence and leaf size sometimes differ between the two species, these characteristics may be dependent on season and locality. On the other hand, the angle of the lateral veins in the leaf blade may be used to distinguish the congeners. In *L. melissifolia*, the lowest two pairs of lateral veins of the leaf blade diverge at a 45°–50° angle from the midrib, and distal to this, successive veins diverge at approximately 35° (Steyermark, 1949). In other words, the lower two lateral veins are not parallel to the successive upper veins. In contrast, all lateral veins of *L. benzoin* leaves diverge from the midrib at the same angle (35°–45°); therefore, are parallel (Steyermark 1949). Both Nuttall (1818) and Steyermark (1949) described the fruits of *L. melissifolia* as "larger" than those of *L. benzoin*. The senior author has found the seeds of the congeners to be consistently reliable for definitive identification of fruiting plants. While seeds of *L. melissifolia* are spherical and light brown to yellowish brown, those of *L. benzoin* are oval and dark brown (Fig. 1D).

In 1986, *L. melissifolia* was listed under the Federal Endangered Species Act of 1973 (U.S. Fish and Wildlife Service 1986). Recent research has provided some insight into the ecophysiology (Hawkins et al. 2009b; Aleric & Kirkman 2005) of this species, and forest types and forest structure associated with *L. melissifolia* in the LMAV have been reported (Hawkins et al. 2009a). Wright (1990) suggested species of *Brunnichia*, *Rubus*, and *Smilax* as main competitors of *L. melissifolia* in northeast Arkansas, and that periodic flooding served to minimize competitive interactions. Beyond Wright's (1990) initial report, very little is known about the microhabitat or biotic interactions in *L. melissifolia* colonies. In an effort to provide concise information regarding the microhabitat and general ecology of *L. melissifolia*, three native, disjunct populations in Mississippi were monitored for three years. The objectives of our study were to 1) assemble a vascular plant checklist of groundcover species growing within *L. melissifolia* colonies, 2) identify potential competitors of *L. melissifolia*, and 3) monitor hydrologic regime for *L. melissifolia* colonies.

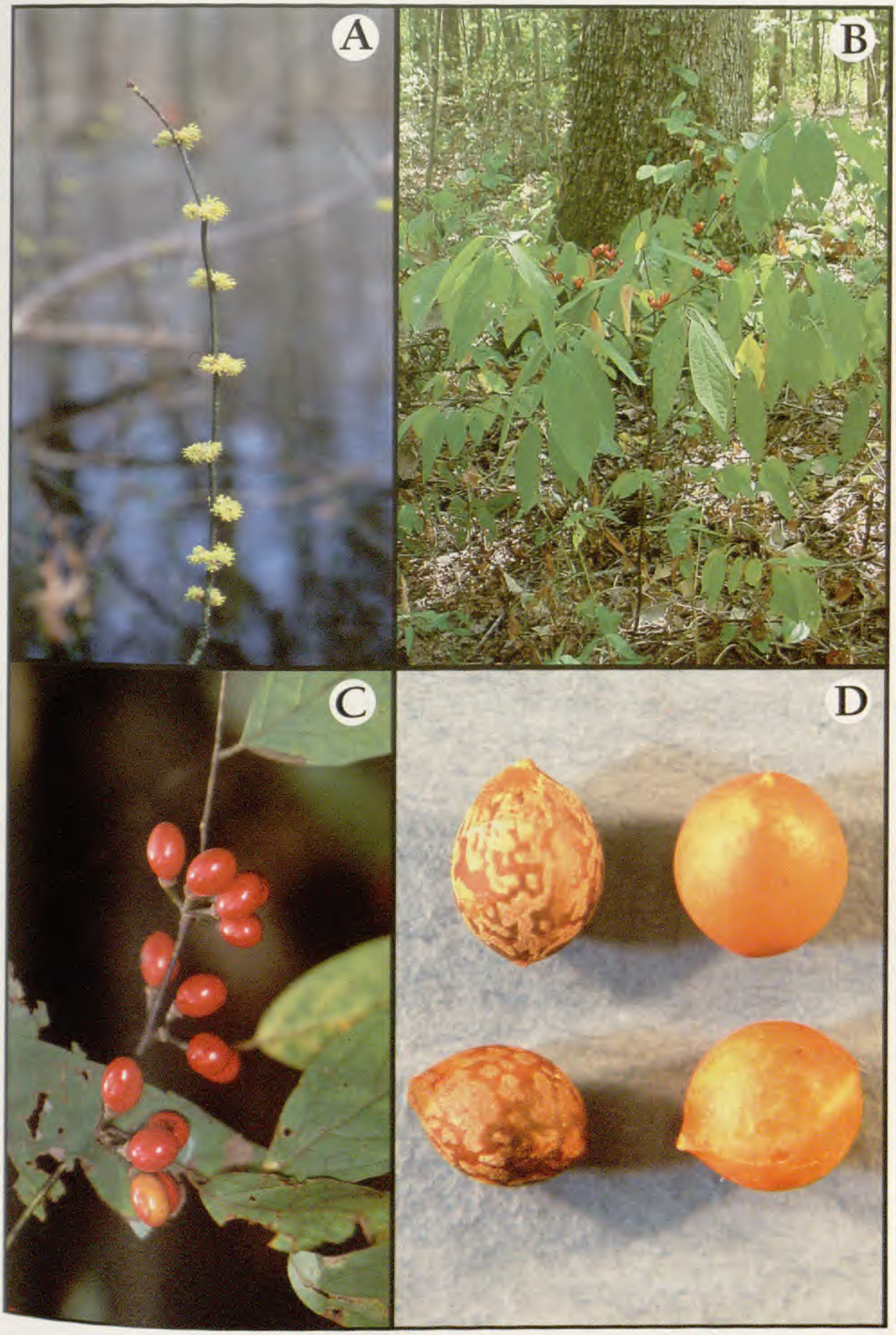

FIG. 1. (A) flowering *Lindera melissifolia* stem, (B) reproductively mature *L. melissifolia* plant, (C) mature drupes on female *L. melissifolia*, and (D) seeds of *L. benzoin* (left) and *L. melissifolia* (right).

METHODS

Study Sites

Two of the study sites are in Sharkey County, Mississippi. The North Delta National Forest site (NDNF) is a 25-ha tract of Delta National Forest that has been under management by the U. S. Forest Service since 1938 (Devall & Ramp 1992). The South Delta National Forest (SDNF) site is a 10-ha tract of forest approximately 9 km southeast of NDNF. The third study site (BC) is in Bolivar County, Mississippi, and is a privately owned 30-ha forest fragment surrounded by agricultural fields (see Hawkins et al. 2009a for map and detailed descriptions). Soil association for the three sites is Dowling (very fine, smectitic, nonacid, thermic Vertic Endoaquepts)-Alligator (very-fine, smectitic, thermic Chromic Dystraquerts)-Sharkey (very-fine, smectitic, thermic Chromic Epiaquerts), an association characterized by poorly drained, fine-textured clayey surface soils and subsoils formed from Mississippi River alluvium (Rogers 1958, Scott & Carter 1962). Mean annual temperature for Sharkey and Bolivar counties is approximately 18.0°C, and total annual precipitation ranges from 1228 mm to 1319 mm (Rogers 1958, Scott & Carter 1962).

Data Collection and Analysis

In autumn 2003, rectangular plots were established for selected *L. melissifolia* colonies at BC ($N_{colony} = 6$), NDNF ($N_{colony} = 10$), and SDNF ($N_{colony} = 1$). In 2000, SDNF was habitat for numerous *L. melissifolia* colonies, many with >200 stems (GSRC 2000). However, during reconnaissance of this area we found only one remaining colony and were able to establish only one study plot. The perimeter of each plot was positioned 1m beyond the outermost *L. melissifolia* stems of a colony. A 1.2 m wooden stake (5 cm x 5 cm) was established at each of the four corners of the rectangular plot. Colony sizes were variable, and thus plot areas varied with colony size. Within each plot, 1m x 1m quadrats were marked with pin flags along the diagonals of the rectangular plot; therefore, the percent of plot area sampled was the same among plots.

In June 2004, May 2005, and June 2007, *L. melissifolia* stems in each 1m x 1m quadrat within the plots were counted, and groundcover species were identified and stems were counted. Common plants were identified in the field by TSH and DAS. When field identification was problematic, plants in question were top-cropped and taken to the lab for identification using Radford et al. (1968), supplemented by Godfrey and Wooten (1979, 1981).

From 10 November 2004 to 22 May 2007, plots were visited bi-weekly. When plots were not flooded, two soil samples were collected from each plot and placed in individual 141 cm^3, hermetically sealed, metal containers. Soil samples were taken directly to the lab, weighed to the nearest 0.01 g, dried in an oven at 70°C for 48 hr, then weighed again. Percent moisture for each soil sample was calculated by dividing the difference of initial (wet) and final (dry) weights by the initial weight and multiplying the quotient by 100. During flooded conditions, water depth was measured to the nearest 0.1 cm at each plot corner post and the mean (± SE) used to represent water depth for the plot.

At NDNF, there were substantial differences in water depth among some of the *L. melissifolia* colonies; therefore, mean water levels for each sampling date at each colony were compared using a one-way analysis of variance (ANOVA; SAS 2001). For colonies where mean water level was not significantly different ($p \geq 0.2421$), data were pooled producing one mean ± standard error for each of three groups of colonies.

RESULTS AND DISCUSSION

Hydrologic regime for forests with *Lindera melissifolia* populations is often described within the broad definition of "periodically flooded". For populations in Mississippi, flooding generally occurred in late-winter to late-spring. However, flooding events and flood duration were found to vary among sites. The BC population experienced annual flooding events of comparable depth and duration in 2005, 2006, and 2007 (Fig 2A). Flooding at this site is artificially controlled by the landowner; therefore, hydrologic regime remains consistent from year to year.

Flood duration and initial time of flooding varied with year at NDNF. Flooding occurred in 2005 and 2006, but not in 2007 (Fig. 2B). Although water depth differed among some of the ten monitored colonies at

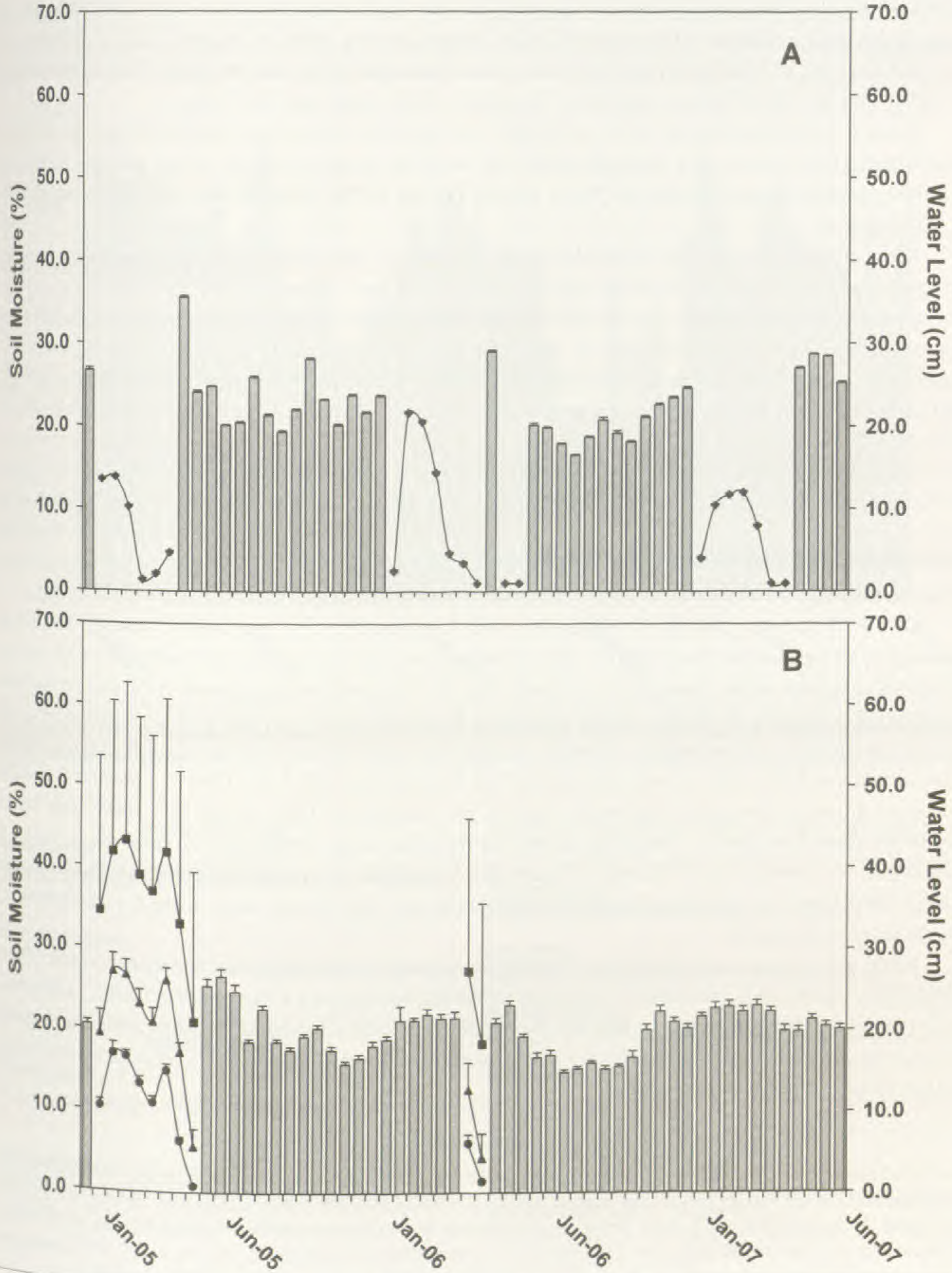

Fig. 2. Mean (± SE) soil moisture content (bars) and water level (lines) for *Lindera melissifolia* colonies, at the (A) BC site (N_{colony} = 6) in Bolivar County, Mississippi and (B) NDNF site (N_{colony} = 10) in Sharkey County, Mississippi. For NDNF site, ■ = plot 1, ▲ = plots 2, 3, 5, 8, and ● = plots 4, 6, 7, 9, 10 as segregated by ANOVA.

NDNF, this had no influence on time and duration of individual colony inundation (Fig. 2B). Difference in water depth among colonies is the result of surface topography (e.g. sinks or sloughs). Lack of difference in time and duration of flooding between colonies results from rapid rising and dropping of water. In contrast to NDNF and BC, SDNF did not experience flooding in 2005, 2006, and 2007 (Fig. 3).

When *L. melissifolia* colonies were not flooded, soil moisture content was comparable among the three sites, ranging from 20% to 30% throughout the year, with the exception of mid- to late-summer, when soil moisture contents dropped as low as 15% to 18% for BC and NDNF (Figs. 2A and 2B); and as low as 10% at SDNF (Fig 3).

The combined annotated list of vascular plants (including *L. melissifolia*) for the three study sites includes 70 species in 57 genera in 45 families (Appendix 1) and of these, 9 species have the potential to become weedy or invasive (SWSS 1998). The contribution of *L. melissifolia* to overall colony composition ranged from approximately 20%–40% at NDNF and BC, and 5%–15% at SDNF (Fig. 4). Other species growing within the colonies are typical of bottomland hardwood forests in this area of the LMAV, and tend to reflect hydrologic regime at each study site. Forty-nine percent of the 69 species identified as growing in association with *L. melissifolia* (Appendix 1) have a wetland indicator status of FACW and a 67%–99% probability of occurrence in a wetland area (USDA, NRCS 2008). However, the presence of *Callicarpa americana* at SDNF is atypical for bottomland forests in the LMAV and represented a county record first reported in 2007 (Skojac et al. 2007). Lack of inundation at SDNF (Fig. 3) has possibly allowed establishment of *C. americana*, as well as other species, such as *Asplenium platyneuron* and *Phytolacca americana*, that generally are not found in forests prone to flooding.

Of the 69 species growing in association with *L. melissifolia*, few appeared to pose an immediate above-ground competitive threat and the ratio of stem density for these plants to *L. melissifolia* stem density remained relatively stable throughout our study (Fig. 4). The predominant growth habit in *L. melissifolia* colonies was vines (Fig 4). Wright (1990) considered *Brunnichia ovata* as a plant with potential to be an aggressive competitor of *L. melissifolia*; however, we observed early-summer emergence of *B. ovata*, as well as *Toxicodendron radicans*, after *L. melissifolia* plants had flowered and leafed out. Both *B. ovata* and *T. radicans* remained prostrate throughout the season and did not compromise light capture by *L. melissifolia* leaves, nor twine around or climb *L. melissifolia* stems. On the other hand, *Smilax* spp. (*S. bona-nox*, *S. glauca*, *S. rotundifolia*, *S. tamnoides*) and *Vitis* spp. (*V. aestivalis*, *V. palmata*, *V. rotundifolia*) have potential to become strong competitors, by remaining upright throughout the year, and in some cases, using *L. melissifolia* stems for above-ground support.

Many of the associated species in *L. melissifolia* colonies in Mississippi do not appear to have direct competitive impact on *L. melissifolia* populations. However, species with a vining growth habit and/or those with potential to become weedy or invasive (Appendix 1), should continue to be monitored. The response of these species to natural or anthropogenic disturbances has the potential to alter competitive interactions within these *L. melissifolia* populations.

APPENDIX 1

Plants included in this checklist are compiled in alphabetical order by family within two major groups (Monilophytes and Angiosperms). Genera and species are alphabetical within each family. Scientific nomenclature and common names follow The Plants Database (USDA, NRCS 2008). Family circumscriptions for monilophytes follow The Plants Database (USDA, NRCS 2008), and for angiosperms, APG (Stevens 2008). Plants with potential to become weedy or invasive (SWSS, 1998) are denoted with an asterisk (*) before the species name. Species wetland indicator status for the Southeast Region (AL, AR, FL, GA, LA, MS, NC, SC, TN) is noted as: **OBL** = obligate (99% probability of occurrence in wetlands); **FACW** = facultative wetland (67% - 99% probability of occurrence in wetlands, but occasionally found in non-wetlands); **FAC** = facultative (equal probability of occurrence in wetlands or non-wetlands); **FACU** = facultative upland (occurrence usually in non-wetlands, occasional wetland occurrence); and **NI** = unable to determine wetland indicator status based solely on genus. Locality data are noted as: (**1**) = Bolivar County, MS; (**2**) = North Delta National Forest, Sharkey County, MS; and (**3**) = South Delta National Forest, Sharkey County, MS.

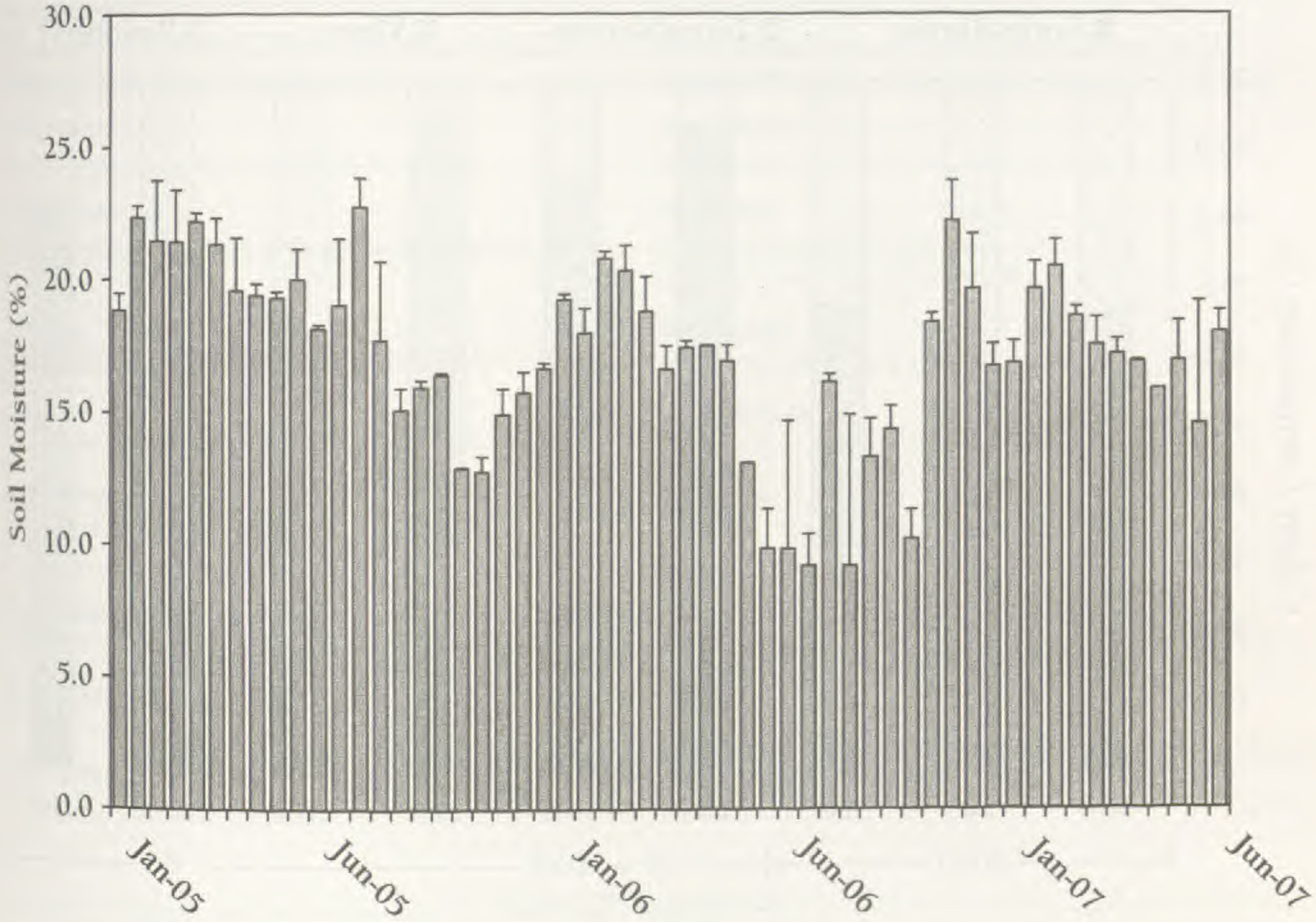

Fig. 3. Mean (± SE) soil moisture content for a *Lindera melissifolia* colony at the SDNF site in Sharkey County, Mississippi. No flooding events occurred at this site during the study period.

MONILOPHYTES

Aspleniaceae

Asplenium platyneuron (L.) Britton, Sterns & Poggenb., ebony spleenwort, FACU, (3)

Ophioglossaceae

Botrychium biternatum (Sav.) Underw., sparselobe grapefern, FAC, (3)

ANGIOSPERMS

Acanthaceae

Justicia ovata (Walter) Lindau, looseflower water-willow, OBL, (2)

Anacardiaceae

**Toxicodendron radicans* (L.) Kuntze, eastern poison ivy, FAC, (1,2,3)

Apiaceae

Cynosciadium digitatum DC., finger dogshade, FACW, (1)

Sanicula canadensis L., Canadian black snakeroot, FACU, (3)

Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, clustered black snakeroot, FAC, (2,3)

Apocynaceae

Matelea gonocarpos (Walter) Shinners, angularfruit milkvine, FACW, (1)

Trachelospermum difforme (Walter) A. Gray, climbing dogbane, FACW, (1,2,3)

Aquifoliaceae

Ilex decidua Walter., possumhaw, FACW, (2)

Arecaceae

Sabal minor (Jacq.) Pers., dwarf palmetto, FACW, (2)

Aristolochiaceae

Aristolochia serpentaria L., Virginia snakeroot, FACU, (2)

Asteraceae

Erechtites hieracifolia (L.) Raf ex DC., American burnweed, FAC, (1,3)

Eupatorium sp. L., thoroughwort, NI, (3)

Bignoniaceae

Bignonia capreolata L., crossvine, FAC, (3)

**Campsis radicans* (L.) Seem ex Bureau, trumpet creeper, FAC, (2,3)

Cannabaceae

Celtis laevigata Willd., sugarberry, FACW, (1,2)

Commelinaceae

Commelina virginica L., Virginia dayflower, FACW, (2)

Cornaceae

Cornus foemina Mill., stiff dogwood, FACW, (2)

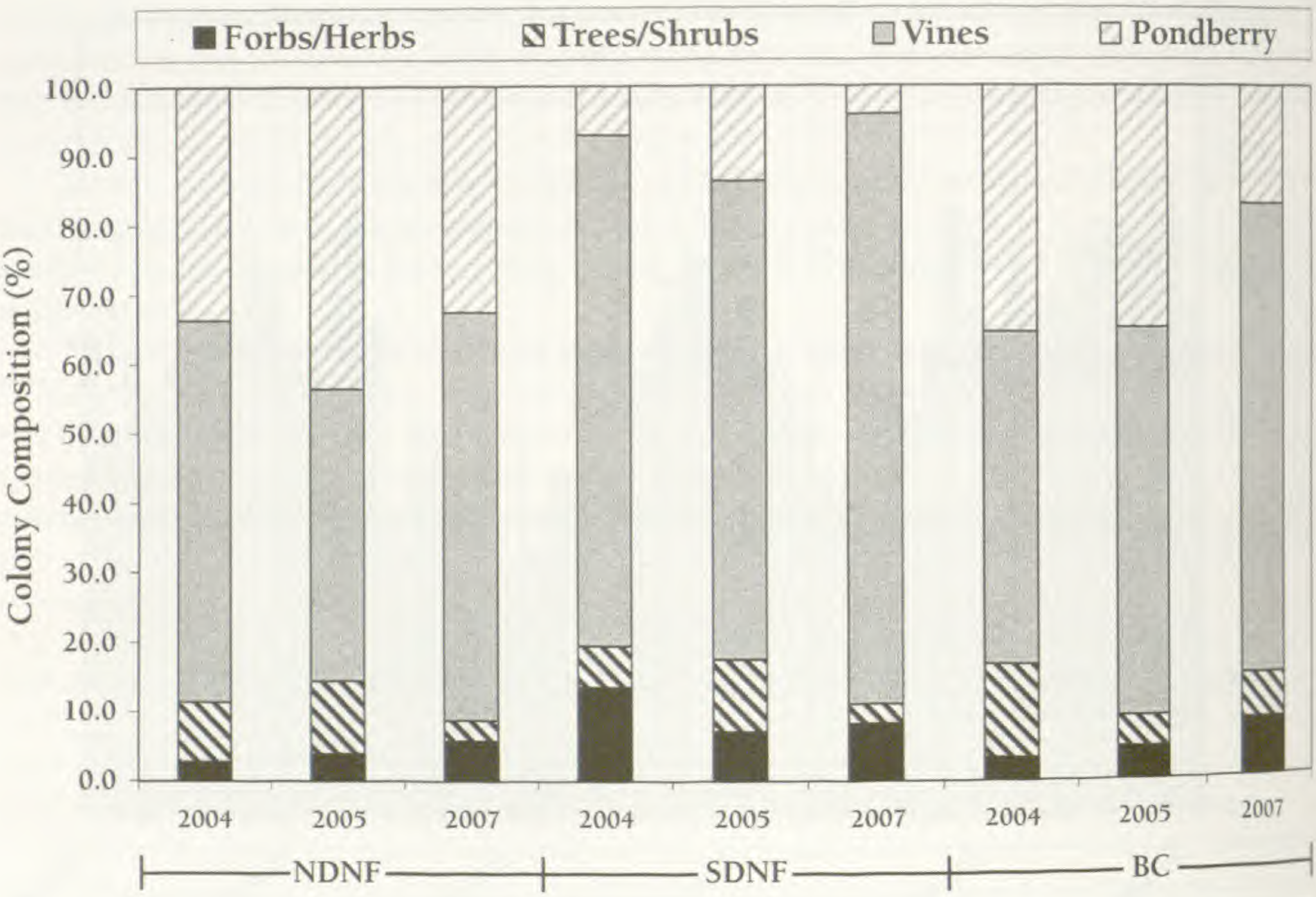

Fig. 4. Percent contribution of *Lindera melissifolia* (Pondberry), vines, trees/shrubs, and forbs/herbs to *Lindera melissifolia* colony composition in three populations in Sharkey (NDNF & SDNF) and Bolivar (BC) counties, Mississippi. Percentages calculated from the number of stems of each growth habit per unit area (stems/m^2).

Cucurbitaceae
Melothria pendula L., Guadeloupe cucumber, FACW, (3)

Cyperaceae
Carex crus-corvi, Shuttlw. ex Kunze, ravenfoot sedge, OBL, (1)
Carex louisianica L.H. Bailey, Louisiana sedge, OBL, (2)
Carex tribuloides Wahlenb., blunt broom sedge, FACW, (1,2)

Ebenaceae
Diospyros virginiana L., common persimmon, FAC, (2)

Fabaceae
Desmodium sp. Desv., ticktrefoil, NI, (3)
Dioclea multiflora (Torr. & A. Gray) C. Mohr, Boykin's clusterpea, FAC, (2,3)
Gleditsia triacanthos L., honeylocust, FAC, (1,3)

Fagaceae
Quercus lyrata Walter, overcup oak, OBL, (1,2)
Quercus nigra L., water oak, FAC, (3)
Quercus phellos L., willow oak, FACW, (1,2,3)
Quercus texana Buckley, Texas red oak, OBL, (1,2)

Hamamelidaceae
Liquidambar styraciflua L., sweetgum, FAC, (1,2)

Juglandaceae
Carya aquatica (Michx. f) Nutt., water hickory, OBL, (2)

Lauraceae
Lindera melissifolia (Walt.) Blume, OBL, (1,2,3)
Sassafras albidum (Nutt.) Nees., sassafras, FACU, (2)

Menispermaceae
**Cocculus carolinus* (L.) DC., Carolina coralbead, FAC, (2,3)

Moraceae
Morus rubra L., red mulberry, FAC, (2)

Oleaceae
Forestiera acuminata (Michx.) Poir., swamp privet, OBL, (2)
Fraxinus pennsylvanica Marsh., green ash, FACW, (1,2,3)
Fraxinus profunda (Bush) Bush, pumpkin ash, OBL, (1)

Onagraceae
Ludwigia glandulosa Walter, cylindricfruit primrose-willow, OBL, (1)

Orchidaceae
Spiranthes ovalis Lindl., October lady's tresses, FAC, (2)

Passifloraceae
**Passiflora lutea* L., yellow passionflower, FAC, (2)

Phytolaccaceae
**Phytolacca americana* L., American pokeweed, FACU, (3)

Poaceae
Leersia virginica Willd., whitegrass, FACW, (1,2)

Polygonaceae
*_Brunnichia ovata_ (Walter) Shinners, redvine, FACW, (1,2,3)
Polygonum virginianum L., jumpseed, FAC, (2)

Ranunculaceae
Clematis crispa L., swamp leatherflower, FACW, (2)

Rhamnaceae
Berchemia scandens (Hill) K. Koch, Alabama supplejack, FACW, (1,2,3)

Rosaceae
Rubus trivialis Michx., southern dewberry, FAC, (3)

Rubiaceae
Cephalanthus occidentalis L., common buttonbush, OBL, (2)

Sapindaceae
Acer negundo L., boxelder, FACW, (3)
Acer rubrum L., red maple, FAC, (1,2)

Sapotaceae
Sideroxylon lycioides L., buckthorn, FACW, (1,2)

Saururaceae
*_Saururus cernuus_ L., lizard's tail, OBL, (2)

Smilacaceae
Smilax bona-nox L., saw greenbrier, FAC, (1,2,3)
Smilax glauca Walter, cat greenbrier, FAC, (2)
Smilax rotundifolia L. roundleaf greenbrier, FAC, (1,2,3)
Smilax tamnoides L., bristly greenbrier, FAC, (2)

Styracaceae
Styrax americanus Lam., American snowbell, FACW, (2)

Ulmaceae
Planera aquatica J.F. Gmel., water elm, OBL, (2)
Ulmus americana L., American elm, FACW, (1,2,3)

Urticaceae
Boehmeria cylindrica (L.) Sw., false nettle, FACW, (2,3)

Verbenaceae
Callicarpa americana L., American beautyberry, FACU, (3)

Violaceae
Viola sp. L., violet, NI, (3)

Vitaceae
*_Ampelopsis arborea_ (L.) Koehne, peppervine, FAC, (1,2,3)
*_Parthenocissus quinquefolia_ (L.) Planch., Virginia creeper, FAC, (1,2,3)
Vitis aestivalis Michx. summer grape, FAC, (2)
Vitis palmata Vahl., catbird grape, FACW, (1,2)
Vitis rotundifolia Michx., muscadine, FAC, (2,3)

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VASCULAR FLORA OF THE OLD MULKEY MEETING HOUSE STATE HISTORIC SITE, MONROE COUNTY, KENTUCKY

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ABSTRACT

A floristic study was conducted of the vascular plants of Old Mulkey Meeting House State Historic Site, the oldest wooden meeting house west of the Appalachian Mountains, in Monroe County, Kentucky, during the 2008 and 2009 growing seasons. Old Mulkey, built in 1797, gives its name to the only state park in Kentucky to perpetuate the name and commemorate the history of a church. Vascular plants from the 32.0 hectare site consisted of 415 species in 266 genera from 105 families. Taxonomic distribution included 10 species of Polypodiophyta, five species of Pinophyta, and 400 species of Magnoliophyta (301 Magnoliopsida, 99 Liliopsida). Eighty-three (20.00%) were naturalized or introduced exotics with 43 (51.81%) invasive plant pest species. A total of 319 species (76.87%) were Monroe County distribution records. The species richness value was +1.03. Plant communities include predominantly mesophytic and oak-hickory forests and culturally disturbed areas.

Key Words: vascular plants, invasive plants, plant communities, oak-hickory forest, mesophytic forest, Old Mulkey Meeting House State Historic Site, Monroe County, Kentucky, Kentucky State Parks

RESUMEN

Se hizo un estudio florístico de las plantas vasculares del lugar histórico Old Mulkey Meeting House—la casa de reuniones religiosas más antigua de madera construida al oeste de los montes Apalaches—en el condado de Monroe del estado de Kentucky durante las temporadas de crecimiento de los años 2008 y 2009. Old Mulkey, construida en 1797, da su nombre al único parque estatal de Kentucky que conmemora y perpetúa el nombre de una iglesia. Las plantas vasculares del terreno de 32 hectáreas pertenecen a 415 especies de 266 géneros y 105 familias. La distribución taxonómica comprendió 10 especies de Polypodiophyta, cinco especies de Pinophyta y 400 especies de Magnoliophyta (301 Magnoliopsida, 99 Liliopsida). Ochenta y tres (20.00%) fueron naturalizadas o exóticas introducidas con 43 (51.81%) especies de plantas invasoras nocivas. Un total de 319 especies (76.87%) fueron oficialmente documentadas para el condado de Monroe. El valor de riqueza de las especies fue +1.03. Las comunidades de plantas que predominan incluyen bosques mesofíticos de roble-nogal y lugares perturbados por humanos.

Palabras Claves: plantas vasculares, plantas invasivas, las comunidades de plantas, bosque de roble-nogal americano, bosque mesofítico, lugar histórico estatal Old Mulkey Meeting House, condado de Monroe, estado de Kentucky, parques estatales de Kentucky

INTRODUCTION

Old Mulkey Meeting House State Historic Site, hereafter Old Mulkey, is the only state park in Kentucky to venerate the name and commemorate the history of a church. The historic site was designated to preserve the Old Mulkey Meeting House, the oldest wooden building of its kind in Kentucky and the oldest meeting house west of the Appalachians. Old Mulkey is located 0.6 km from the city limits of Tompkinsville adjoining KY 1446 (Old Mulkey Road) in south-central Monroe County, Kentucky, at latitude 36.679722°N and longitude 85.705556°W. Monroe County is a southernmost Kentucky county bordering Clay County, Tennessee (Fig. 1). Old Mulkey became a part of the Kentucky State Parks system on November 8, 1931, as the Old Mulkey Meeting House State Shrine (Kentucky State Parks 2009).

Old Mulkey is comprised of 32.0 hectares in the unglaciated Eastern Highland Rim of the Interior Low Plateau based on Keys et al. (1995) and Woods et al. (2002). Old Mulkey encompasses a continuum of natural forest vegetation, woodlands, and anthropogenically disturbed (semi-natural and modified) vegeta-

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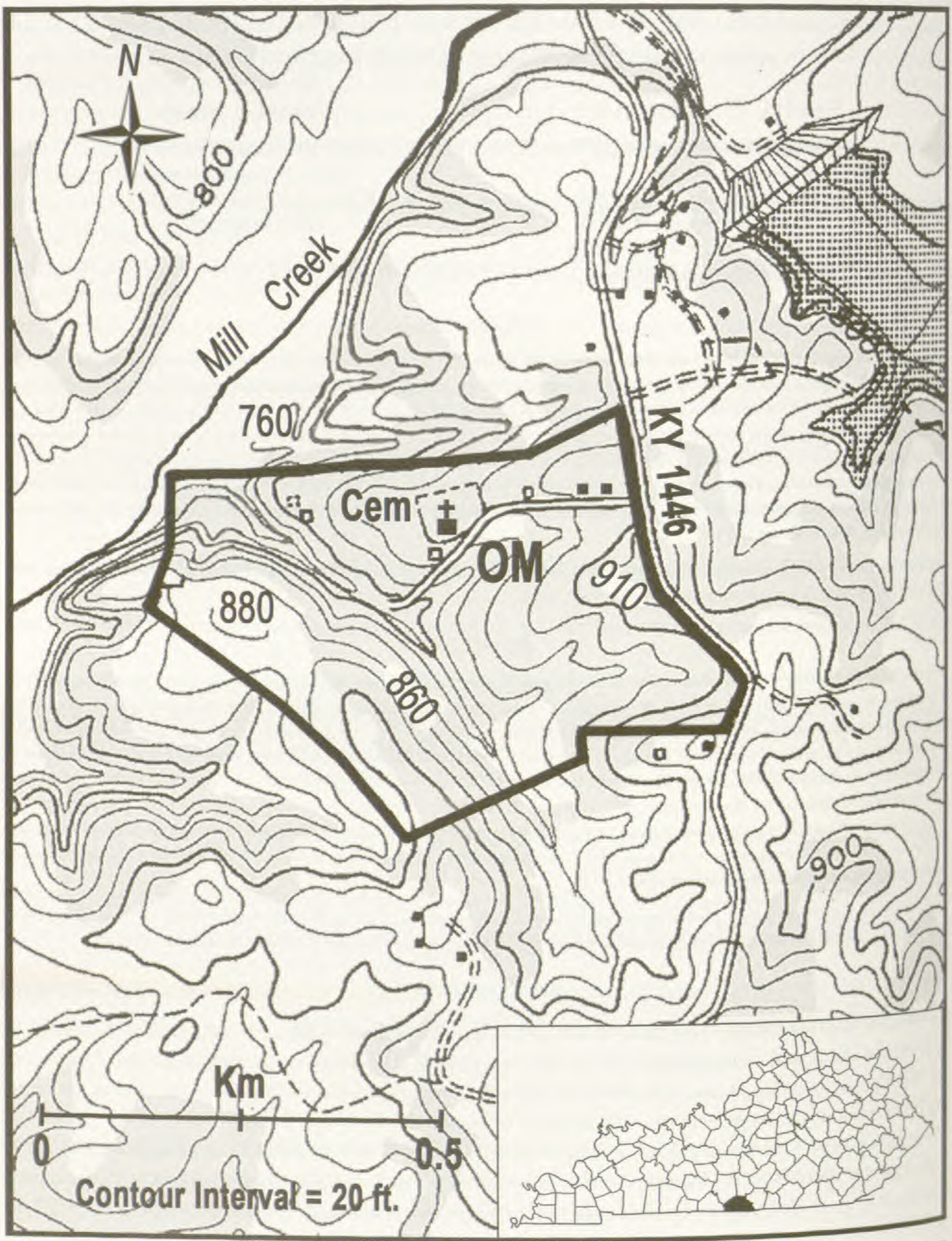
N
800
Mill Creek
760
Cem
OM
880
910
KY 1446
860
900
Km
0
0.5
Contour Interval = 20 ft.

FIG. 1. Old Mulkey Meeting House State Historic Site, 0.6 km southwest of Tompkinsville city limits, Monroe County, Kentucky. Map adapted from Tompkinsville Topographic Quadrangle (GQ-937) Kentucky, 7-5 minute series (1:24,000 scale), U.S Geological Survey, 1954. Inset of Monroe County within Kentucky.

tion. The terrain consists of upland ridges, rolling to steep hillsides, rock outcrops, drainage gullies, toe slopes, a narrow ravine, and an alluvial terrace. The topography then transitions to near level slopes with an admixture of forest woodlands bordering a large, open grassy yard. Elevations range from 230 m at the junction of the Mill Creek floodplain to 274 m on an upland area adjoining KY 1446. The historic site features the Old Mulkey Meeting House, a Revolutionary War patriot and pioneer cemetery, a Visitor Center, an Old Visitor Center, a maintenance building, a picnic and playground area, and a large mowed yard primarily of graminoid herbaceous species.

A descriptive floristic study was undertaken of the Old Mulkey Meeting House State Historic Site during the 2008–2009 growing seasons. An extensive herbarium search (BEREA, EKY, KY, WKU) revealed a paucity of Monroe County plant specimens from a few incidental collections. Our objectives were to: 1) document the vascular plants with representative voucher specimens, 2) describe the plant communities present with characteristic species, 3) determine Monroe County distribution records, 4) discuss geology, soils, and climate of the physical site, 5) prepare an annotated species list with county records, origin (native or exotic), invasive plant pest status, vernacular name, plant communities, relative abundance, and collection number(s) for each taxon, and 6) establish a baseline inventory for further botanical study in Monroe County.

THE STUDY SITE

History

Old Mulkey Meeting House represents both the Pioneer Era and the Great Religious Revival Era in the development of Kentucky history in the early 1800s. Philip Mulkey led a small group of Baptist settlers to Kentucky in 1773 from what is now North Carolina and South Carolina. The congregation established the Mill Creek Baptist Church in 1797 at the current site of the Old Mulkey Meeting House. This group was a part of the Religious Restoration Movement, known as "The First Great Awakening," that swept the south after the Revolutionary War partly to declare separation from the established church in England. John Mulkey, brother to Philip, became the first minister of the church in 1797 (Rogers 1960).

On April 15, 1804, the growing congregation commissioned the building of a new meeting house church. It measured 15.24 m × 9.14 m and was built with 12 corners representing the 12 Apostles and three doors symbolic of the Holy Trinity. It had five windows, a puncheon floor, clapboard shutters, hand-driven shingles, chinked and daubed walls, and split-log peg-leg benches (Kentucky State Parks 2009).

On November 18, 1809, the congregation of 200 members split into two factions over differences in John Mulkey's religious doctrine. After this schism, 150 members remained with John Mulkey and retained the church building, which then became known as "Old Mulkey" or "Old Mulkey Meeting House." The 50 remaining members of the congregation left and established a new Baptist church in Tompkinsville (Rogers 1960). John Mulkey was a well-respected preacher in the Baptist Association for 53 years and delivered over 10,000 sermons before he died at Old Mulkey on December 13, 1844 (Rogers 1960). After Mulkey's death, religious services continued to be held at Old Mulkey until 1856, after which the existing congregation disbanded and its former members moved to the Church of Christ in Tompkinsville. Old Mulkey was abandoned following the dissolution of the church (Kentucky State Parks 2009).

In the 1870s, Old Mulkey Meeting House was renovated and was used for various religious meetings and events until 1910, when it was again abandoned. In 1925, the Honorable Joe H. Eagle, U.S. Representative and Monroe County native, and Reverend William Thomas of Tompkinsville initiated a successful campaign to rebuild and restore Old Mulkey to its 1804 form (Fig. 2). Through their efforts and others, the Old Mulkey Meeting House and cemetery were designated a Kentucky state shrine by the Kentucky State Park Commission on November 8, 1931 (Kentucky State Parks 2009).

The cemetery at Old Mulkey is the final resting place of 76 Old Mulkey pioneer parishioners, many of whom were Revolutionary War soldiers. Among those gravestone markers are Hannah Boone (1746–1828) (Fig. 2), Lieutenant Nathan Breed, James Chism, John Giss, Joseph Gist, William Howard, Obadiah Howard, Philip Mulkey, John Newton Mulkey (son of John Mulkey), Edward Pediford, General Samuel Wilson

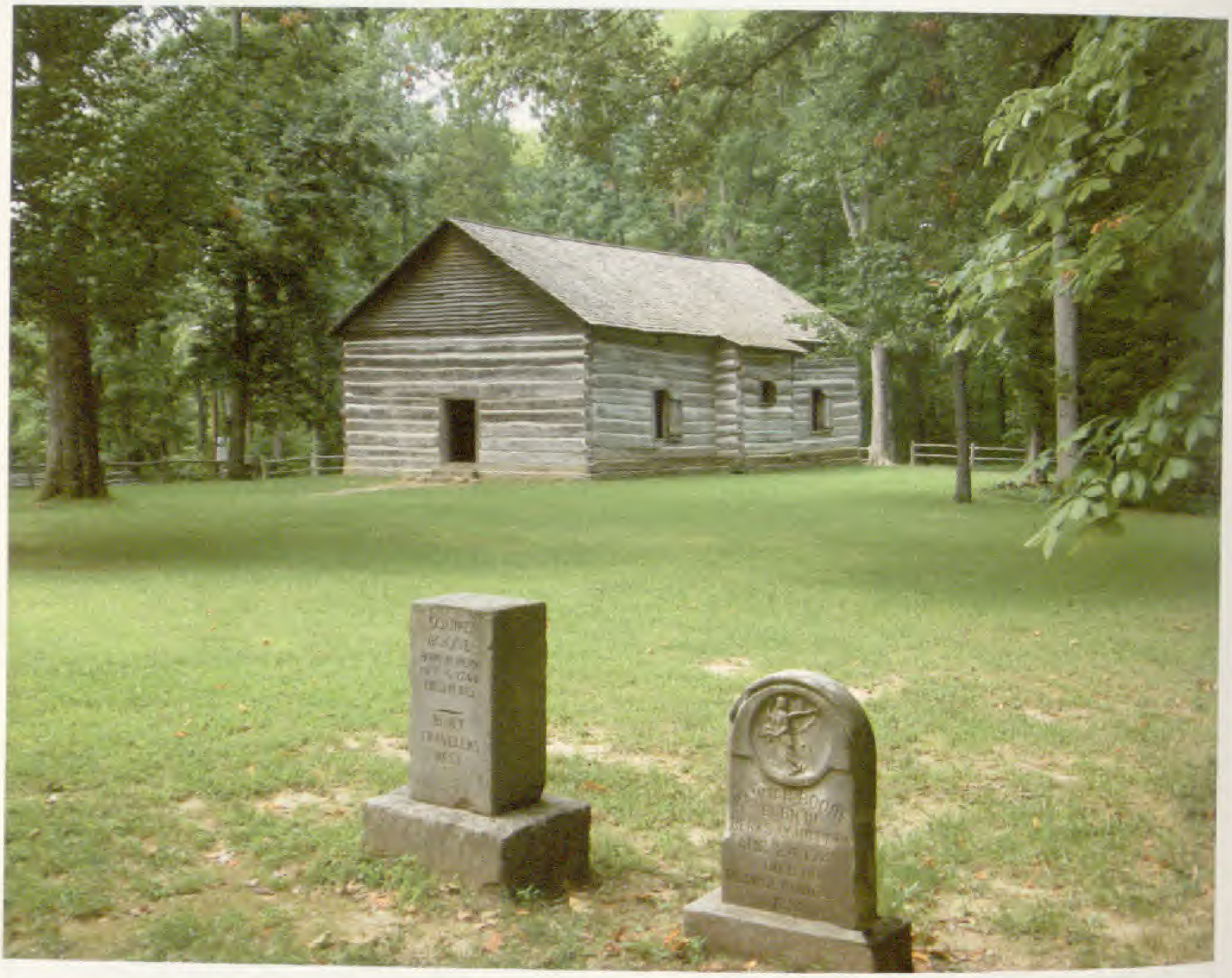

Fig. 2. Old Mulkey Meeting House and Cemetery, with markers of Daniel Boone's sister Hannah Boone and brother Squire Boone.

(donator of the Old Mulkey land site), and four children of Isaac Jackson, cousin of Confederate General Stonewall Jackson (Kentucky State Parks 2009).

Forest Vegetation

Küchler (1964) maps the potential vegetation in this southern part of Kentucky as Oak-Hickory Forest. Oak-Hickory Forest is the predominant forest vegetation in upland drier areas in Monroe County, and Mixed Mesophytic Forest is an important forest type in mesic ravines near the Cumberland River of the Interior Low Plateau (Woods et al. 2002). Braun (1950) classified the vegetation in the Mississippian Low Plateau Region with predominately shale and limestone bedrock in the vicinity of Old Mulkey, as belonging to the Western Mesophytic Forest, a mosaic of Oak-Hickory Forest to the west and Mixed Mesophytic Forest to the east. At Old Mulkey, Mesophytic Forest is the principal forest vegetation type. The number of canopy species, high herbaceous diversity, and leaf litter and duff accentuate the mesophytic aspects of the forest. It is present on mesic upland hillside slopes, midslopes, lower slopes, drainage gullies, a ravine, and a floodplain terrace. Oak-Hickory Forest is found on the extensive xeric upland ridges, rolling hillsides, outcrops, gullies, and among altered woodland stands.

Geology

Quaternary alluvium of sand, pebbles, and gravels is present on the lower adjoining intermittent creek and spring-fed creek at the Mill Creek floodplain from 231 m to 237 m. Mississippian greenish-gray to gray to yellowish-gray shaly siltstones (green soapstones) of the Fort Payne Formation are found on hillside slopes and the spring creek ravine near Mill Creek and upper elevations from 237 m to 256 m (Witkind 1971).

Mississippian shaly siltstones, greenish-gray to light gray weathering to yellowish-gray of the Salem and Warsaw Limestones are present on gentle side slopes and hillsides to the upper elevations from 256 m to 252 m (Witkind 1971). These calcareous shales are not distinguishable from the shaly siltstone beds of the underlying Fort Payne Formation and often form rock outcrops. From 252 m to 275 m, Salem and Warsaw Limestones underlie the upland areas of Old Mulkey to the eastern boundary with KY 1446. Exposed limestone outcrops consist of medium to dark gray, thick-bedded, fine to medium carbonate grains with fossil fragments and tightly cemented oolites (Witkind 1971).

Soils

The soils of the Garmon Association form an almost continuous band from the spring-fed ravine to the steep 20–60% west-trending hillside slope adjacent to Mill Creek. Garmon Shaly Silt Loams on 12–20% slopes lie along the ravine slopes and upper hillside slopes near the northern boundary (Mitchell & Latham 1982). These residual soils are medium acidic to neutral in reaction, moderately deep to 100–152 cm deep, well-drained, and are composed of calcareous shaly limestone bedrock. Lowell Silt Loams of 2–6% slopes, are found around the old cemetery and picnic area and also lie on small upland benches and ridges on 6-12% slopes south of the Visitor's Center. These interbedded limestone, shale, and siltstone residual soils are strongly acid to neutral in reaction, well-drained, gently sloping and are less than 122–152 cm deep to bedrock (Mitchell & Latham 1982). Waynesboro Loams of 6–12% slopes and 12–20% slopes are present in much of the uplands around the Visitor's Center and along the KY 1446 roadside shoulders. These residual soils are strongly acid or very strongly acid in reaction, well-drained, and 61–203 cm deep on moderately steep upland slopes. Waynesboro Clay Loams of 6–12% to 12–30% slopes lie on hillside slopes at the southeastern boundary area. These residual, well-drained soils are strongly acidic to very strongly acidic in reaction and 96–203 cm deep (Mitchell & Latham 1982).

Climate

The continental climate of south-central Kentucky is temperate, humid mesothermal with little water deficiency, warm to hot summers, and mild to cold winters (Trewartha & Horn 1980). Kentucky climatic data (1971–2000) are from the weather station at Summer Shade, Metcalfe County, ca. 35 km northwest of the Old Mulkey site. Mean annual precipitation is 128.0 cm with March the highest at 13.0 cm and October the lowest at 8.1 cm, and includes a mean annual snowfall of 27.7 cm with 20.8 cm in January and February. Mean annual temperature is 13.8°C with January the coldest month at 1.4°C and July the warmest month at 24.8°C. Median length of the growing season is 183 days with April 17 the median last spring frost and October 18 the median first fall frost (Kentucky Climate Center 2009).

METHODS

Vascular plants were collected from 17 all day field trips during the growing seasons of 2008 (10 trips) and 2009 (7 trips). The master voucher specimen set for this floristic study is deposited at the Berea College Herbarium (BEREA). Vernacular names are derived from Chester et al. (2009) or USDA, NRCS (2010). The symbols for origin of taxa are from Thompson (2008). Nomenclature of taxa and classification of families is based on Jones (2005), except in the case of a few woody plants where the nomenclature follows Clark and Weckman (2008). Jones (2005) and Gleason and Cronquist (1991) were used in identification of taxa and for determining native or exotic status. Monroe County records are based on Campbell and Medley (2006), Clark and Weckman (2008), and USDA, NRCS (2009). The relative abundance scale in the annotated list is based on Thompson (2007). A single relative abundance or occurrence value (rare, scarce, infrequent, occasional, frequent, abundant) is assigned for each taxon and is inclusive for all plant communities. Invasive pest plant status (severe threat, significant threat, lesser threat) is from the Kentucky Exotic Plant Pest Council list (KY-EPPC 2009). Relative species richness was derived from the species-area equation ($S = 272A^{0.113}$) of Wade and Thompson (1991). A predicted species richness (S) may be calculated by inserting a known value in hectares (A) and a deviation value calculated from actual number of species divided by predicted number of species.

A plant community is defined as an assemblage of associated species with a definite floristic composition under relatively consistent habitat conditions with a uniform physiognomy (Thilenius 1968). Our floristic plant communities are based on Thilenius's concept: the structural physiognomy, species composition of the characteristic or diagnostic canopy, subcanopy, and herbaceous species, and habitat diversity (combination of physiographic terrain, soils, geology, and topographic-moisture relief).

RESULTS AND DISCUSSION

Taxonomic Summary

Vascular flora of Old Mulkey consists of 415 species in 266 genera from 105 families (Table 1). In several cases, an infraspecific category, i.e., subspecies or variety, is given for a species, but in no instance is there more than one infraspecific category per species. Taxonomic distribution includes 10 species of Polypodiophyta, five species of Pinophyta, and 400 species of Magnoliophyta (301 Magnoliopsida, 99 Liliopsida). Eighty-three (20.00%) are naturalized or introduced exotics (Table 1). Ninety-six (23.13%) were woody and 319 (76.87%) were herbaceous species. A total of 319 species (76.87%) are Monroe County distribution records, which is indicative of an inadequately collected county. No rare state-listed taxa were encountered based on KSNPC (2009). The families containing the most species are the Asteraceae (51), Poaceae (46), Fabaceae (25), Cyperaceae (24), Rosaceae (17), Scrophulariaceae (11), and Lamiaceae (10). *Carex* is the largest genus with 21 taxa.

The presence of the recently-described, facultative calciphile, *Carex superata*, is significant. This rare sedge is growing on the lower slope of a small mesic ravine in Garmon calcareous shaly silt loam soils adjacent to a spring-fed creek at Old Mulkey. In Kentucky, this taxon is near its northern range limit; it has only been documented from three counties bordering Tennessee; Cumberland, Monroe, and Todd Counties (Naczi et al. 1998).

Species Richness

Using the species-area curve for floras in the Mixed and Western Mesophytic Forest Regions (Wade & Thompson 1991), the predicted species richness is 402 species for a 32.0-ha site. The actual species richness at Old Mulkey is 415 species. The relative species richness from the actual species number divided by the predicted species gave a deviation value of +1.03%. This species richness value is indicative of an ample survey for the Old Mulkey study site.

Invasive Species

At Old Mulkey, 43 (51.80%) of the naturalized species are invasive plant pests based on the Kentucky Exotic Pest Plant Council list (KY-EPPC 2009). Eighteen invasive species are classified as "severe threat" plants. The worst woody invasive, *Vinca minor*, forms extensive ground cover over approximately 4.0 ha of the Mesophytic Forest community. *Lonicera japonica* is found throughout both Mesophytic Forest and Oak-Hickory Forest. *Pueraria montana* var. *lobata* is entangled in localized areas of the Oak-Hickory Forest. Among the "severe threat" species, *Ailanthus altissima*, *Celastrus orbiculatus*, *Euonymus alatus*, *Ligustrum sinense*, *Lonicera maackii*, and *Rosa multiflora*, are growing in a small restricted area of Oak-Hickory Forest and forest woodland ecotones east of the Visitor's Center and adjacent to KY 1446. Thirteen "significant threat" invasives and 12 "lesser threat" invasives are present within the boundaries of Old Mulkey. The majority of the invasives are widespread herbaceous species in culturally disturbed habitats, e.g., mowed yard of the historic site and the KY 1446 roadside shoulders contiguous with the eastern boundary of Old Mulkey in Oak-Hickory Forest. Two introduced exotic trees, *Koelreuteria paniculata* and *Pyrus calleryana*, are planted at the Old Visitor's Center.

The consequences of not controlling woody naturalized invasives will ultimately continue to impact the native flora, vegetation, and habitats at Old Mulkey Meeting House State Historic Site and its environs. Invasive plant species have the deleterious effects of displacing and out-competing native species, changing the pattern of progressive plant succession, influencing decomposition processes, and disrupting nutrient cycles (Poindexter & Thompson 2009). Among the "severe threat" taxa, *Celastrus orbiculatus*, *Euonymus alatus*,

Table 1. Taxonomic distribution of vascular plants of the Old Mulkey Meeting House, Kentucky.

Division	Family	Genera	Species	Native	Exotic	Species composition (%)
Polypodiophyta	5	8	10	10	0	2.41
Pinophyta	2	3	5	5	0	1.20
Magnoliophyta	98	255	400	317	83	96.39
Liliopsida	17	54	99	78	21	23.86
Magnoliopsida	81	201	301	239	62	72.53
Total:	105	266	415	332	83	100.00

Lonicera maackii, and *Vinca minor*, have extended their geographical range based on the maps of Clark and Weckman (2008). All severe threat woody invasive species, except for *Lonicera japonica* and *Vinca minor*, could be controlled because of the small areas of establishment at the current time. Treatments for effectively removing and destroying aggressive invasive woody pest plants at Old Mulkey are highly recommended through foliar application, hack and spray, and/or cut/paint stem-stump applications of herbicides (e.g., triclopyr with 2.4-D and glyphosate).

Plant Communities

Plant communities are described with physical features and characteristic species in the predominant Mesophytic Forest and Oak-Hickory Forest types. Plant communities are further discussed within these two major forest community types in context including ecotonal forest woodland border, intermittent creek drainage area, and culturally disturbed areas. The anthropogenically derived plant community includes the historic site mowed yard, cemetery, playground, picnic area, and the roadside shoulder and ditch of asphalt-paved KY 1446 (Old Mulkey Road).

Mesophytic Forest.—The Mesophytic Forest community encompasses the largest part of the forested Old Mulkey site, and it forms a mosaic throughout with the Oak-Hickory Forest community on upland hillside slopes, midslopes, lower slopes, side slopes, and drainage gullies on the central to western and northern boundaries. Mesophytic Forest continues through a mesic west-facing ravine with a natural spring-fed creek, ravine slopes, and toe slopes, and it ends in an alluvial floodplain terrace near the junction with Mill Creek at the extreme western boundary. The closed-canopy is comprised primarily of very shade tolerant to partially shade tolerant trees. Diagnostic canopy trees in general order of abundance are *Fagus grandifolia*, *Acer saccharum*, *Quercus alba*, *Q. rubra*, *Liriodendron tulipifera*, *Carya cordiformis*, *Aesculus flava*, *Fraxinus americana*, *Q. muhlenbergii*, *Morus rubra*, *Nyssa sylvatica*, *Ulmus rubra*, and *Tilia americana*. In species composition, this forest community is comparable to a combination of the *Fagus grandifolia-Acer saccharum-(Liriodendron tulipifera)* Forest Alliance and the *Fagus grandifolia-Quercus rubra-Quercus alba* Forest Alliance of the Land Between The Lakes National Recreation Area (NatureServe 2004). Evans (1991) characterizes this forest type as the Acidic Mesophytic Forest. Several large mesophytic trees, *Acer saccharum*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Quercus alba*, *Q. falcata*, *Q. muhlenbergii*, and *Q. rubra*, are 0.70 m dbh or greater. Trees measuring over 1.0 m dbh are *Fagus grandifolia* and *Quercus alba*.

A well developed tall-shrub layer and woody vines are present particularly within the spring-fed ravine. Characteristic taxa are *Asimina triloba*, *Bignonia capreolata*, *Corylus americana*, *Hydrangea arborescens*, *Ilex opaca*, *Lindera benzoin*, *Menispermum canadense*, *Sambucus canadensis*, *Smilax hispida*, *Staphylea trifolia*, *Viburnum acerifolium*, and *Vitis rotundifolia*. The most abundant invasive woody plant, *Vinca minor*, forms extensive ground cover in several upland and lowland mesic areas.

In the Mesophytic Forest community, the species richness increases with the presence of several spring ephemeral species especially within the spring-fed ravine. Indicator perennials include *Arisaema triphyllum*, *Asarum canadense*, *Carex amphibola*, *C. cumberlandensis*, *C. kraliana*, *C. oligocarpa*, *C. rosea*, *Erythronium americanum*, *Galium triflorum*, *Iris cristata*, *Maianthemum racemosum*, *Pachysandra procumbens*, *Poa autumnalis*, *P. sylvestris*, *Polygonatum pubescens*, *Ranunculus recurvatus*, *Sanguinaria canadensis*, *Sanicula trifoliata*, *Sedum ternatum*, *Smilax ecirrhata*, and *Trillium grandiflorum*. Holoparasitic herbs, *Conopholis americana* on *Quercus rubra*, and widespread *Epifagus virginiana* on *Fagus grandifolia*, are present on middle to upper slopes. Mesic ferns present in the shaly calcareous ravine are *Adiantum pedatum*, *Botrychium virginianum*, *Cystopteris protrusa*, *Diplazium pycnocarpon*, *Phegopteris hexagonoptera*, and *Polystichum acrostichoides*.

Herbaceous species of the shale-layered ravine bottom, lower slopes, and toe slopes, include *Boehmeria cylindrica*, *Campanulastum americanum*, *Carex albursina*, *C. laxiflora* var. *laxiflora*, *C. superata*, *Cryptotaenia canadensis*, *Erigenia bulbosa*, *Glyceria striata*, *Hydrophyllum macrophyllum*, *Impatiens capensis*, *I. pallida*, *Laportea canadensis*, *Leersia virginica*, *Osmorhiza claytonii*, *Phlox divaricata*, *Pilea pumila*, *Stellaria pubera*, and *Viola striata*. Naturalized annual herbs invading throughout mesic areas are *Microstegium vimineum* and *Polygonum caespitosum* var. *longisetum*.

An alluvial floodplain terrace from the spring-fed creek of the Mesophytic Forest community leads westward to Mill Creek. Riparian trees at this site are *Acer negundo*, *Carpinus caroliniana*, *Fraxinus pennsylvanica*, *Platanus occidentalis*, and *Salix nigra*. *Vinca minor* also extensively covers much of the toe slope and floodplain terrace. Canopy trees, shrubs, and vines on this floodplain terrace are those species of the Mesophytic Forest as are the typical native spring, summer, and fall perennials.

Intermittent Creek Drainage Community.—At the northwestern boundary of the Mesophytic Forest community, an intermittent seasonal creek with a gravel and cobble bed adjoins a shaly spring-fed creek. Various weedy native and exotic species have colonized the gravel bottom, embankments, and northwest to western-trending floodplain. *Cuscuta pentagona* is a holoparasite on *Ambrosia artemisiifolia*, *A. trifida*, *Bidens frondosa*, *Lespedeza cuneata*, and *Polygonum caespitosum* var. *longisetum*. Among other herbaceous taxa in the creek drainage are *Amphicarpaea bracteata*, *Desmodium glabellum*, *Impatiens capensis*, *Iva annua*, *Physalis longifolia*, *Polygonum punctatum*, and *Xanthium strumarium* var. *glabratum*. Taxa of lower floodplain thickets include *Ageratina altissima*, *Circaea lutetiana* subsp. *canadensis*, *Clematis virginiana*, *Collinsonia canadensis*, *Coreopsis triloba*, *Lactuca floridana*, *Rubus occidentalis*, *Solidago gigantea*, *Verbena urticifolia*, and *Verbesina occidentalis*.

Oak-Hickory Forest.—The vegetation of upland, dry rolling hills, slopes, and gullies is predominantly a dry-mesic Oak-Hickory Forest community on the eastern and northeastern boundaries. A mixture of intermediate shade tolerant to shade intolerant oaks with a hickory component along with several Mesophytic species best describes this forest community. It is comparable to the *Quercus alba*-(*Quercus rubra*, *Carya* spp.) Forest Alliance of the Land Between The Lakes National Recreation Area (NatureServe 2004). The Oak-Hickory Forest community blends with the Mesophytic Forest community on uplands throughout and borders the culturally disturbed community as ecotonal forest-woodland edges. Diagnostic hardwood canopy trees in general order of abundance are *Quercus alba*, *Fagus grandifolia*, *Acer saccharum*, *Q. rubra*, *Q. stellata*, *Q. velutina*, *Q. falcata*, *Carya ovata*, *C. tomentosa*, *C. glabra*, *Acer rubrum*, *Fraxinus americana*, *Nyssa sylvatica*, *Diospyros virginiana*, *Sassafras albidum*, *Ulmus alata*, and *Prunus serotina*. Scattered coniferous stands of *Juniperus virginiana* and a plantation of *Pinus taeda* and *P. strobus* are intermixed among taxa of the Oak-Hickory Forest community on the north-trending upper to middle slope at the southern boundary. Mid-to-late secondary succession stages are occurring as intermediate shade-tolerant hardwoods volunteer throughout the understory. Subcanopy trees, tall-shrubs, and vines include *Campsis radicans*, *Cercis canadensis*, *Cornus florida*, *Euonymus americanus*, *Frangula caroliniana*, *Ostrya virginiana*, *Parthenocissus quinquefolia*, *Smilax rotundifolia*, *Symphoricarpos orbiculatus*, *Viburnum rufidulum*, *Vitis aestivalis*, *V. rotundifolia*, and the ubiquitous *Toxicodendron radicans*. The major woody invasive species are *Lonicera japonica* and *Pueraria montana* var. *lobata*.

Several seasonal herbaceous species are found in the dry-mesic Oak-Hickory Forest community on ridges, hillsides, limestone outcrops, and gullies; however, species richness is not nearly as significant as in the Mesophytic Forest community. Characteristic perennial taxa include *Arisaema triphyllum*, *Brachyelytrum erectum*, *Carex blanda*, *C. digitatus* var. *digitalis*, *C. oligocarpa*, *C. planispicata*, *C. willdenowii*, *Circaea lutetiana* subsp. *canadensis*, *Claytonia virginica*, *Conoclinium coelestinum*, *Cynoglossum virginianum*, *Dentaria multifida*, *Desmodium nudiflorum*, *Dichanthelium acuminatum*, *D. boscii*, *Galium circaezans*, *G. pilosum*, *Goodyera pubescens*, *Oxalis violacea*, *Phryma leptostachya*, *Podophyllum peltatum*, *Polygonum virginianum*, *Sanicula canadensis*, *Scutellaria elliptica*, *Solidago caesia*, *Tipularia discolor*, and *Viola palmata*. Ferns include *Asplenium platyneuron*, *Botrychium dissectum*, *B. virginianum*, *Phegopteris hexagonoptera*, *Polystichum acrostichoides*, and *Woodsia obtusa*.

A unique stand of Oak-Hickory Forest is found on a steep, west-trending shaly hillside above Mill Creek at the southwestern boundary. Dominant canopy trees and shrubs include those characteristic of the Oak-Hickory Forest community. Some indicator species found only on the thin soil, calcareous shaly outcrops at the upper and midslope are *Carex communis*, *Coreopsis major*, *Dodecatheon meadia*, *Heuchera americana*, *Porteranthus stipulatus*, *Saxifraga virginiensis*, and *Solidago sphacelata*. Other characteristic species include *Agrostis perennans*, *Arabis laevigata*, *Asplenium platyneuron*, *Carex albicans*, *Houstonia purpurea*, *Paronychia canadensis*, *Solidago caesia*, and *Sphenopholis nitida*. The exposed soils of the lower slope are colonized by *Cystopteris bulbifera*, *Eurybia macrophylla*, *Hydrangea arborescens*, *Lindera benzoin*, and *Sambucus canadensis*.

Ecotonal Woodland Border.—A forest ecotonal woodland border of Oak-Hickory Forest and Mesophytic Forest surrounds the Culturally Disturbed community of the historic site. The flora consists of an admixture of seral woody and herbaceous species from the Oak-Hickory Forest, Mesophytic Forest, and the Culturally Disturbed yard. This secondary successional woodland community has an assemblage of shade-intolerant to very shade-intolerant woody species. *Pinus virginiana*, *Rhus copallina*, *Robinia pseudoacacia*, *Rosa carolina*, *Rubus argutus*, *Smilax bona-nox*, *S. glauca*, *Toxicodendron radicans*, *Ulmus alata*, and *Vaccinium corymbosum*, are present along with the saplings of several intermediate to shade-intolerant species of *Carya* and *Quercus*. Suffrutescent plants include *Chimaphila maculata* and *Hypericum stragulum*. Herbaceous species occupying this community include *Agrimonia rostellata*, *Antennaria plantaginifolia*, *Carex albicans*, *Desmodium glabellum*, *Dichanthelium commutatum*, *D. laxiflorum*, *Elephantopus carolinianus*, *Erigeron annuus*, *E. philadelphicus*, *Galium aparine*, *Hypericum punctatum*, *Juncus tenuis*, *Luzula echinata*, *Oxalis violacea*, *Ruellia caroliniensis*, *Salvia lyrata*, *Scutellaria nervosa*, and *Viola sororia* var. *sororia*. The omnipresent *Lonicera japonica* and *Toxicodendron radicans* are interspersed along these ecotonal forest woodland edges among numerous other woody and herbaceous taxa.

A small open, xeric woodland border of Oak-Hickory Forest has a herbaceous floristic composition of several prairie species descriptive of a prairie-like barren. This mid-seral stage community is found on a south-trending hillside edge near the spring and southwest of the Old Mulkey Meeting House adjacent to the mowed yard. Characteristic perennial graminoids are *Andropogon virginicus* var. *virginicus*, *Carex hirsutella*, *Dichanthelium commutatum*, *D. laxiflorum*, *Elymus glabriflorus*, and *Tridens flavus*. Broad-leaved annual and perennial prairie-like forbs include *Asclepias tuberosa*, *Aureolaria virginica*, *Chamaecrista nictitans*, *Croton monanthogynus*, *Desmodium rotundifolium*, *Diodia teres*, *Erigeron strigosus*, *Euphorbia corollata*, *Hieracium gronovii*, *Krigia biflora*, *Lespedeza intermedia*, *L. procumbens*, *Manfreda virginica*, *Packera anonyma*, *Penstemon canescens*, *Solidago nemoralis*, *Spiranthes tuberosa*, and *Vernonia gigantea*.

The secondary succession prairie-like barren community has been severely influenced by continual mowing of all the perennial prairie species during the last two years. The mowing practice has continually been expanding the established mowed yard area into the woodland prairie-like border. This close mowing practice is effectively destroying the herbaceous prairie species by allowing encroachment of undesirable naturalized grasses from the yard and an increase in embankment erosion. It is recommended that this prairie-like barrens community should not be mowed at all to allow for natural plant succession.

Culturally Disturbed Community.—Anthropogenic affects on the flora diversity at the Old Mulkey site have occurred numerous times throughout its history. The Culturally Disturbed community includes plants occupying the extensive mowed yard, cemetery, playground and picnic area, asphalt and gravel roadsides, disturbed ground by a maintenance building, and the ruderal KY 1446 roadside shoulder and ditch contiguous with the ecotonal woodland border. Anthropogenic influences have created a weedy vegetation of many exotic and native annuals, some biennials, and several perennial herbs of the Asteraceae, Brassicaceae, Caryophyllaceae, Fabaceae, Lamiaceae, Poaceae, and Polygonaceae, among other families. *Cynodon dactylon*, *Digitaria sanguinalis*, *Festuca arundinacea*, *Paspalum pubiflorum*, *Poa compressa*, and *P. pratensis* are the principal grasses in the mowed yard. Naturalized annual and perennial herbs include *Cardamine hirsuta*, *Cerastium vulgatum*, *Draba verna*, *Lespedeza stipulacea*, *L. striata*, *Medicago lupulina*, *Ornithogalum umbellatum*, *Poa annua*, *Sherardia arvensis*, *Stellaria media*, *Taraxacum officinale*, *Trifolium dubium*, *T. repens*, and *Veronica arvensis*. Native herbaceous taxa include *Ambrosia artemisiifolia*, *Carex cephalophora*, *C. glaucodea*, *Claytonia virginica*, *Dentaria multifida*, *Euphorbia maculata*, *E. nutans*, *Gamochaeta purpurea*, *Houstonia caerulea*, *Juncus tenuis*, *Krigia virginica*, *Luzula echinata*, *Oxalis stricta*, and *Viola sororia* var. *sororia*. The introduced *Narcissus pseudonarcissus* has persisted in the cemetery among an intense ground cover of *Vinca minor*. A few naturalized herbaceous plants only found at one ground-disturbed site around a maintenance building near the Visitor's Center are *Amaranthus spinosus*, *Anagallis arvensis* var. *arvensis*, *Cerastium glomeratum*, *Chenopodium album*, *Fatoua villosa*, *Lolium perenne* var. *aristatum*, *Mentha* ×*piperita*, *Secale cereale*, *Thlaspi alliaceum*, *Triticum aestivum*, and *Veronica polita*.

The KY 1446 mowed roadside shoulder and ditch are colonized by many of the same ruderal naturalized and native taxa present in the culturally disturbed yard. Characteristic forbs include *Allium vineale*, *Ambrosia artemisiifolia*, *Bidens bipinnata*, *Carduus nutans*, *Chrysanthemum leucanthemum*, *Cichorium intybus*, *Coronilla varia*, *Daucus carota*, *Lactuca saligna*, *Melilotus alba*, *Sonchus asper*, *Verbascum blattaria*, and *V. thapsus*. Grasses include *Andropogon virginicus* var. *virginicus*, *Bromus commutatus*, *Dactylis glomerata*, *Digitaria sanguinalis*, *Eleusine indica*, *Festuca arundinacea*, *Paspalum pubiflorum*, *Setaria pumila*, *Sorghum halepense*, and *Tridens flavus*.

ANNOTATED LIST OF SPECIES

The annotated list is arranged alphabetically by family, genus, and species in the Polypodiophyta, Pinophyta, and Magnoliophyta (Magnoliopsida and Liliopsida). Each taxon entry has a symbol code preceding the scientific name for Monroe County record (¤), naturalized exotic species (*), invasive plant species (**), introduced exotic species (‡), and native planted species (†). A vernacular name, plant community type(s), an inclusive relative abundance value, and representative voucher specimen number(s) ensue for every taxon. After the vernacular name, a code for plant communities follows: **OF** (Oak-Hickory Forest), **MF** (Mesophytic Forest), **WB** (Forest Woodland Ecotone Border), **IC** (Intermittent Creek Drainage), and **CD** (Culturally Disturbed Community). These communities are listed in sequence of importance for a characteristic species present in two or more communities.

A relative abundance value for each taxon from all plant communities is: **R** (Rare)—1–4 plants or colonies, very difficult to find in one or two locations; **S** (Scarce)—5–10 plants or colonies, difficult to find in a few locations; **I** (Infrequent)—11–30 plants or colonies, scattered in some locations; **O** (Occasional)—31–100 plants or colonies, widely scattered in several locations; **F** (Frequent)—101–1000 plants or colonies, easily found in numerous locations; and **A** (Abundant)—greater than 1000 plants or colonies, diagnostic or dominant species throughout many locations. An italicized voucher specimen(s) collection number by the first author in a *year-number* (e.g., *08-558*; *09-757*) format ends each taxon entry.

POLYPODIOPHYTA

Aspleniaceae

Asplenium platyneuron (L.) BSP., Ebony spleenwort; OF; O; *08-558, 09-757*

Dryopteridaceae

¤*Cystopteris bulbifera* (L.) Bernhardi, Bulblet bladder fern; OF; S; *08-651*

Cystopteris protrusa (Weath.) Blasdell, Southern bladder fern; MF; R; *08-738, 09-668*

¤*Diplazium pycnocarpon* (Spreng.) M. Broun, Narrow-leaved glade fern; MF; F; *08-566, 09-670*

Polystichum acrostichoides (Michx.) Schott, Christmas fern; MF, OF; F; *08-752*

¤*Woodsia obtusa* (Spreng.) Torr., Blunt-lobed cliff fern; OF; R; *08-868*

Ophioglossaceae

¤*Botrychium dissectum* Spreng., Cut-leaved grape fern; OF; S; *09-776*

Botrychium virginianum (L.) Sw., Rattlesnake fern; OF, MF; *08-285*

Pteridaceae

¤*Adiantum pedatum* L., Northern maidenhair fern; MF; S; *08-567*

Thelypteridaceae

¤*Phegopteris hexagonoptera* (Michx.) Fée, Broad beech fern; OF, MF; I; *08-650*

PINOPHYTA

Cupressaceae

†*Chamaecyparis nootkatensis* (Lamb.) Spach., Nootka cypress; CD; R; *09-14*

Juniperus virginiana L., Eastern red cedar; OF, WB; O; *08-625*

Pinaceae

†*Pinus strobus* L., Eastern white pine; OF; I; *08-766*

†*Pinus taeda* L., Loblolly pine; OF; O; *08-750, 09-678*

¤*Pinus virginiana* Mill., Virginia pine; OF, WB; O; *08-633*

MAGNOLIOPHYTA—MAGNOLIOPSIDA

Acanthaceae

¤*Ruellia caroliniensis* (J.F. Gmel.) Steud., Carolina wild petunia; WB, CD; F; *08-796*

Aceraceae

Acer negundo L., Box-elder; MF, IC; O; *08-661*

Acer nigrum F. Michx., Black maple; OF; S; *08-847*

Acer rubrum L., Red maple; OF, MF, WB; F; *08-598*

Acer saccharum Marshall, Sugar maple; MF, OF; F; *08-590*

Amaranthaceae

¤*Amaranthus spinosus* L., Spiny amaranth; CD; R; *09-677*

Anacardiaceae

Rhus copallina L., Winged sumac; WB, OF; O; *08-761*

Toxicodendron radicans (L.) Kuntze, Eastern poison-ivy; OF; MF, WB; A; *08-354*

Annonaceae

Asimina triloba (L.) Dunal, Paw-paw; MF; IC; *08-594*

Apiaceae

¤*Cryptotaenia canadensis* (L.) DC., Canada honewort; MF; F; *08-705*

¤***Daucus carota* L., Queen Anne's lace; CD; O; *08-617*

¤*Erigenia bulbosa* (Michx.) Nutt., Harbinger-of-spring; MF; F; *09-18*

¤*Osmorhiza claytonii* (Michx.) C.B. Clarke, Clayton's sweet cicely; MF; F; *08-479*

¤*Osmorhiza longistylis* (Torr.) DC., Long-styled sweet cicely; MF; I; *08-390*

¤*Sanicula canadensis* L., Canada black snakeroot; OF; I; *08-794*

¤*Sanicula trifoliata* E.P. Bicknell, Beaked snakeroot; MF, OF; O; *08-603*

¤*Zizia aurea* (L.) W.D.J. Koch, Common golden alexander; MF; S; *09-218*

Apocynaceae

¤*Apocynum cannabinum* L., Indian hemp; OF, WB; I; *08-675*

¤***Vinca minor* L., Lesser periwinkle; MF, WB, CD; A; *09-10*

Aquifoliaceae

¤*Ilex opaca* Aiton, American holly; MF; R; *09-772*

Araliaceae

¤*Aralia spinosa* L., Spiny aralia; MF; I; *08-588*

Aristolochiaceae

¤*Asarum canadense* L., Canada wild ginger; MF; F; *08-386*

Asclepiadaceae

Asclepias tuberosa L., Butterfly-weed; WB; S; *08-683*

¤*Asclepias variegata* L., Red-stem milkweed; WB; R; *08-638*

Asteraceae

¤**Achillea millefolium* L., Common yarrow; WB; S; *08-905*

¤*Ageratina altissima* (L.) R.M. King & H. Rob., White snakeroot; MF, OF, IC; A; *08-922*

¤*Ambrosia artemisiifolia* L., Annual ragweed; CD, IC; F; *08-721*

¤*Ambrosia trifida* L., Great ragweed; IC; O; *08-767*

¤*Antennaria plantaginifolia* (L.) Richardson, Plantain-leaved pussytoes; WB, OF, CD; O; *09-73*

¤*Bidens bipinnata* L., Spanish needles; CD; I; *08-834*

¤*Bidens frondosa* L., Devil's beggar-ticks; IC; I; *09-771*

¤***Carduus nutans* L. subsp. *nutans*, Nodding musk thistle; CD; I; *08-495*

¤***Chrysanthemum leucanthemum* L., Ox-eyed daisy; CD; O; *08-381*

¤***Cichorium intybus* L., Chicory; CD; I; *08-612*

¤*Cirsium discolor* (Muhl. ex Willd.) Spreng., Field thistle; OF, WB; S; *08-837*

¤**Cirsium vulgare* (Savi) Ten., Bull thistle; CD; I; *08-726*

¤*Conoclinium coelestinum* (L.) DC., Blue mistflower; OF, IC; I; *09-672*

¤*Conyza canadensis* (L.) Cronquist, Canada horseweed; CD; O; *08-833*

¤*Coreopsis major* Walter, Greater tickseed; OF; S; *08-553*

¤*Elephantopus carolinianus* Raeusch., Carolina elephant's-foot; OF, MF, WB; O; *08-835*

¤*Erechtites hieraciifolia* (L.) Raf., Fireweed; CD; O; *08-909*

¤*Erigeron annuus* (L.) Pers., Annual daisy fleabane; OF, WB; I; *08-618*

¤*Erigeron philadelphicus* L., Philadelphia fleabane; WB, CD; O; *08-270*

¤*Erigeron strigosus* Muhl. ex Willd., Prairie fleabane; WB; O; *08-465*

¤*Eurybia macrophylla* (L.) Cass., Large-leaved aster; OF; I; *08-862*

¤*Gamochaeta purpurea* (L.) Cabrera, Purple everlasting; CD; I; *08-619*

¤*Hieracium gronovii* L., Beaked hawkweed; WB; O; *08-841*

¤*Iva annua* L., Rough marsh-elder; IC; S; *09-756*

¤*Krigia biflora* (Walter) S.F. Blake, Orange dwarf dandelion; WB; I; *08-273*

¤*Krigia dandelion* (L.) Nutt., Colonial dwarf dandelion; WB; I; *08-286*

¤*Krigia virginica* (L.) Willd., Virginia dwarf-dandelion; CD; F; *08-264*

¤*Lactuca canadensis* L., Canada tall lettuce; WB; CD; I; *08-641*

¤*Lactuca floridana* (L.) Gaertn.,Woodland blue lettuce; IC; I; *08-921*
¤***Lactuca saligna* L., Willow-leaved lettuce; CD; I; *08-901*
¤*Packera anonyma* (Alph. Wood) W.A. Weber & A. Löve, Small's ragwort; WB; O; *08-379*
Packera aurea (L.) A. Löve & D. Löve, Golden ragwort; MF; I; *09-209*
¤*Packera obovata* (Muhl. ex Willd.) W.A. Weber & A. Löve, Rough-leaved groundsel; MF; S; *09-216*
¤*Prenanthes altissima* L., Tall rattlesnakeroot; R; OF; R; *09-775*
¤*Rudbeckia fulgida* Aiton, Orange coneflower; IC; S; *08-865*
¤*Rudbeckia triloba* L. var. *triloba*, Brown-eyed Susan; IC; I; *08-856*
¤*Silphium trifoliatum* L. var. *latifolium* A. Gray, Whole-leaved rosinweed; WB; S; *08-701*
¤*Solidago caesia* L., Axillary goldenrod; MF, OF; F; *08-852*
¤*Solidago canadensis* L., Canada goldenrod; CD, WB, IC; O; *08-915*
¤*Solidago gigantea* Aiton, Smooth goldenrod; MF; I; *09-686*
¤*Solidago nemoralis* Aiton, Old-field goldenrod; WB; O; *08-844*
¤*Solidago sphacelata* Raf., Autumn goldenrod; OF; I; *08-855*
¤**Sonchus asper* (L.) Hill, Prickly sow-thistle; CD; I; *08-914*
¤*Symphyotrichum cordifolium* (L.) G.L. Nesom, Common blue wood aster; MF; I; *08-931*
¤*Symphyotrichum dumosum* (L.) G.L. Nesom, Bushy aster; WB; I; *08-904*
¤*Symphyotrichum lateriflorum* (L.) A. Löve & D. Löve, Calico aster; MF, WB; F; *08-929*
¤*Symphyotrichum ontarionis* (Wieg.) G.L. Nesom, Bottomland aster; IC; S; *08-930*
¤**Taraxacum officinale* (L.) Weber, Common dandelion; CD; F; *08-501*
¤*Verbesina occidentalis* (L.) Walter, Yellow crownbeard; IC; F; *08-923*
¤*Vernonia gigantea* (Walter) Trel., Giant ironweed; WB; R; *08-867*
¤*Xanthium strumarium* L. var. *glabratum* (DC.) Cronquist, Rough cocklebur; IC; I; *08-903*

Balsaminaceae

¤*Impatiens capensis* Meerb., Orange touch-me-not; MF, IC; O; *08-854*
Impatiens pallida Nutt., Pale touch-me-not; MF; O; *08-667*

Berberidaceae

¤*Podophyllum peltatum* L., May-apple; OF, MF; F; *08-246*

Betulaceae

Carpinus caroliniana Walter, American hornbeam; MF; O; *08-461*
Ostrya virginiana (Mill.) K. Koch, Hop-hornbeam; OF; O; *08-587*

Bignoniaceae

Bignonia capreolata L., Cross-vine; MF; F; *09-07*
Campsis radicans (L.) Seem. ex Bureau, Trumpet-creeper; OF, WB; O; *08-582*
***Paulownia tomentosa* (Thunb.) Sieb. & Zucc. ex Steud., Empress tree; OF; R; *09-340*

Boraginaceae

¤*Cynoglossum virginianum* L., Wild comfrey; OF; F; *09-225*
¤*Lithospermum tuberosum* Rugel ex DC., Tuberous stoneseed; OF; I; *08-260*
¤*Myosotis macrosperma* Engelm., WB, CD; O; *08-382*

Brassicaceae

¤*Arabis laevigata* (Muhl. ex Willd.) Poir. var. *laevigata*, Smooth rockcress; OF; I; *08-410*
¤***Barbarea vulgaris* R. Br., Yellow rocket; CD; I; *08-459*
¤**Cardamine hirsuta* L., Hairy bittercress; CD; O; *09-08*
Dentaria laciniata Muhl. ex Willd., Cut-leaved toothwort; MF; R; *09-13*
Dentaria multifida Muhl., Forked-leaved toothwort; OF, WB, CD; A; *08-135, 09-71*
**Draba verna* L., Spring draba; CD; F; *09-15*
¤*Lepidium virginicum* L., Virginia pepperweed; CD; O; *08-756*
**Thlaspi alliaceum* L., Roadside pennycress; CD; R; *09-76*
***Thlaspi perfoliatum* L., Clasping-leaved pennycress; CD; I; *09-19*

Buxaceae

Pachysandra procumbens Michx., Allegheny spurge; MF; A; *09-12*

Campanulaceae

¤*Campanulastrum americanum* (L.) Small, American bellflower; MF; I; *08-703, 09-762*
¤*Lobelia inflata* L., Indian tobacco; WB, CD; O; *08-839*
Triodanis perfoliata (L.) Nieuwl. var. *perfoliata*, Clasping-leaved Venus-looking glass; CD; I; *08-497*

Caprifoliaceae

***Lonicera japonica* Thunb., Japanese honeysuckle; OF, MF, WB; F; *08-441*
¤***Lonicera maackii* (Rupr.) Herder, Amur honeysuckle; OF; S; *08-907*
Sambucus canadensis L., Common black elderberry; MF, IC; O; *08-660, 09-683*
Symphoricarpos orbiculatus Moench, Indian currant; OF; O; *08-846*
¤*Triosteum angustifolium* L., Yellow-fruited horse-gentian; OF; O; *08-261*
Viburnum acerifolium L., Maple-leaved viburnum; MF; I; *08-717*
Viburnum rufidulum Raf., Rusty black haw; OF; R; *08-666*

Caryophyllaceae

¤***Arenaria serpyllifolia* L., Thyme-leaved sandwort; CD; F; *08-266*
¤**Cerastium glomeratum*Thuill., Clammy mouse-eared chickweed; CD; I; *09-212*
¤**Cerastium vulgatum* L., Common mouse-eared chickweed; CD; F; *09-219*
¤*Paronychia canadensis* (L.) Alph. Wood, Canada smooth forked nailwort; OF; O; *08-757*
¤***Stellaria media* (L.) Vill., Common chickweed; CD; F; *08-430*
¤*Stellaria pubera* Michx., Star chickweed; MF; O; *08-394*

Celastraceae

¤***Celastrus orbiculatus* Thunb., Oriental bittersweet; OF; S; *08-898*

¤***Euonymus alatus* (Thunb.) Siebold, Winged burning bush; OF; S; *08-455*

¤*Euonymus americanus* L., Strawberry bush; OF, MF; O; *09-758*

Chenopodiaceae

¤***Chenopodium album* L. var. *album*, Lamb's-quarters; CD; S; *08-550*

Clusiaceae

Hypericum punctatum Lam., Spotted St. John's-wort; WB; I; *08-649*

¤*Hypericum stragulum* W.P. Adams & N. Robson, St. Andrew's-cross; WB; O; *08-709*

Convolvulaceae

¤*Ipomoea lacunosa* L., Whitestar morning-glory; CD; O; *08-899*

¤***Ipomoea purpurea* (L.) Roth, Tall morning-glory; CD; S; *08-861*

Cornaceae

Cornus florida L., Flowering dogwood; OF, MF; F; *08-595*

Crassulaceae

¤*Sedum ternatum* Michx., Woodland stonecrop; MF; F; *08-243*

Cuscutaceae

¤*Cuscuta pentagona* Engelm., Field dodder; IC; R; *08-893, 08-927*

Ebenaceae

Diospyros virginiana L., Common persimmon; OF, MF, WB; O; *09-202*

Ericaceae

¤*Vaccinium corymbosum* L., Highbush blueberry; WB; S; *09-770*

Euphorbiaceae

¤*Acalypha rhomboidea* Raf., Rhomboid three-seeded mercury; IC; O; *08-932*

¤*Acalypha virginica* L., Virginia three-seeded mercury; CD; O; *08-920*

¤*Croton glandulosus* L. var. *septentrionalis* Müell.Arg., Tooth-leaved croton; CD; I; *08-776*

¤*Croton monanthogynus* Michx., Prairie tea; WB; I; *08-772*

¤*Euphorbia commutata* Engelm., Tinted woodland spurge; OF; S; *08-665*

¤*Euphorbia corollata* L., Flowering spurge; WB; R; *08-710*

¤*Euphorbia maculata* L., Spotted sandmat; CD; I; *08-648*

¤*Euphorbia nutans* Lag., Eyebane spurge; CD; R; *08-758*

Fabaceae

¤***Albizia julibrissin* Durazz., Mimosa silktree; WB; S; *08-629*

¤*Amphicarpaea bracteata* (L.) Fernald, American hog peanut; MF; F; *08-925, 09-687*

Cercis canadensis L., Eastern redbud; OF,MF, WB; *08-502, 09-75*

¤*Chamaecrista nictitans* (L.) Moench, Sensitive partridge pea; WB; I; *08-840*

¤***Coronilla varia* L., Crown-vetch; CD; O; *08-910*

¤*Desmodium glabellum* (Michx.) DC., Dillenius' tick-trefoil; WB; O; *09-755*

¤*Desmodium nudiflorum* (L.) DC., Naked-flowered tick-trefoil; MF, OF; F; *08-774*

¤*Desmodium paniculatum* (L.) DC., Panicled tick-trefoil; WB, IC; I; *08-918*

¤*Desmodium pauciflorum* (Nutt.) DC., Few-flowered tick-trefoil; MF; I; *08-762*

¤*Desmodium rotundifolium* DC., Prostrate tick-trefoil; WB; I; *08-760*

Gleditsia triacanthos L., Honey locust; OF; S; *08-406*

¤***Lespedeza cuneata* (Dum.Cours.) G. Don., Sericea lespedeza; CD, IC; O; *08-645*

¤*Lespedeza intermedia* (S. Watson) Britton, Wand lespedeza; WB; R; *08-902*

¤*Lespedeza procumbens* Michx., Downy trailing lespedeza; WB; O; *08-863*

¤***Lespedeza stipulacea* Maxim., Korean clover; CD; A; *09-685*

¤***Lespedeza striata* (Thunb.) Hook. & Arn., Japanese clover; CD; A; *09-676*

¤***Medicago lupulina* L., Black medick; CD; F; *08-469*

¤***Melilotus alba* Medik., White sweet clover; CD; R; *08-631*

¤***Melilotus officinalis* (L.) Pall., Yellow sweet clover; CD; R; *08-634*

¤***Pueraria montana* (Lour.) Merr. var. *lobata* (Willd.) Maesen & S.M. Almeida, Kudzu; OF; O; *08-838*

Robinia pseudoacacia L., Black locust; OF, WB; O; *08-672*

¤**Trifolium campestre* Schreb., Pinnate yellow hop-clover; CD; F; *08-482*

¤**Trifolium dubium* Sibth., Little yellow hop-clover; CD;. A; *08-496*

¤**Trifolium pratense* L., Red clover; CD; F; *08-458*

¤**Trifolium repens* L., White clover; CD; A; *08-500*

Fagaceae

Fagus grandifolia Ehrh., American beech; MF, OF; A; *08-601*

Quercus alba L., White oak; OF, MF; F; *08-591*

Quercus falcata Michx., Southern red oak; OF, MF; F; *08-577*

¤*Quercus imbricaria* Michx., Shingle oak; OF; R; *08-895*

¤*Quercus muhlenbergii* Engelm., Chinkapin oak; MF, OF; F; *08-584*

¤*Quercus rubra* L., Northern red oak; MF, OF; F; *08-711*

¤*Quercus stellata* Wangenh., Post oak; OF; O; *08-684*

Quercus velutina Lam., Black oak; OF, WB; O; *08-597*

Gentianaceae

¤*Sabatia angularis* (L.) Pursh, Common rose pink; CD; R; *08-707*

Geraniaceae

¤*Geranium carolinianum* L., Carolina geranium; CD; O; *09-205*

¤*Geranium maculatum* L., Wild geranium; MF, OF; O; *08-412*

Hamamelidaceae

¤*Hamamelis virginiana* L., Virginia witch-hazel; MF; O; *08-572*

Hippocastanaceae

¤*Aesculus flava* Aiton, Yellow buckeye; MF; F; *08-575, 08-892*

Hydrangeaceae
Hydrangea arborescens L., Wild hydrangea; MF, OF; F; *08-484*

Hydrophyllaceae
¤*Hydrophyllum macrophyllum* Nutt., Large-leaved hairy waterleaf; MF; F; *08-393*

Juglandaceae
¤*Carya alba* (L.) Nutt. ex Elliott, Mockernut hickory; OF, MF; F; *08-585*
¤*Carya cordiformis* (Wangenh.) K. Koch, Bitternut hickory; MF, OF; O; *08-564*
¤*Carya glabra* (Mill.) Sweet, Pignut hickory; OF, MF; *08-754*
¤*Carya ovata* (Mill.) K. Koch, Shagbark hickory; OF, MF; F; *08-579*
Juglans nigra L., Black walnut; OF, MF; I; *08-573*

Lamiaceae
¤*Collinsonia canadensis* L., Canada richweed; MF; S; *09-764*
¤***Glechoma hederacea* L., Ground-ivy; CD; O; *08-655*
¤**Mentha* ×*piperita* L., Peppermint; CD; R; *09-673*
¤*Monarda clinopodia* L., White bergamot; MF; I; *08-476*
¤**Perilla frutescens* (L.) Britton, Perilla mint; CD; O; *08-913*
***Prunella vulgaris* L. var. *vulgaris*, Common self-heal; CD; I; *08-719*
Pycnanthemum pycnanthemoides (Leavenw.) Fernald, Southern mountain mint; WB; R; *08-858*
¤*Salvia lyrata* L., Lyre-leaved wild sage; WB, CD; O; *08-272*
¤*Scutellaria elliptica* Muhl. var. *hirsuta* (Short & R. Peter) Fernald, Hairy skullcap; OF; O; *08-451*
¤*Scutellaria nervosa* Pursh, Veiny skullcap; WB, OF; O; *08-414*

Lauraceae
Lindera benzoin (L.) Blume, Spicebush; MF; F; *09-681*
Sassafras albidum (Nutt.) Nees, Sassafras; OF, WB, MF; O; *08-592*

Loganiaceae
¤*Spigelia marilandica* L., Indian pinkroot; MF; R; *08-475*

Magnoliaceae
Liriodendron tulipifera L., Yellow-poplar; MF, OF; O; *08-467*

Malvaceae
¤*Sida spinosa* L., Prickly sida; CD; I; *08-759*

Menispermaceae
Cocculus carolinus (L.) DC., Carolina coralbeads; MF; I; *08-483*
Menispermum canadense L., Canada moonseed; MF; O; *09-769*

Moraceae
¤**Fatoua villosa* (Thunb.) Nakai, Hairy crabweed; CD; S; *08-720, 09-675*
Morus rubra L., Red mulberry; OF, MF; O; *08-583*

Nyssaceae
Nyssa sylvatica Marsh. var. *sylvatica*, Blackgum; OF, WB, MF; F; *08-636*

Oleaceae
Fraxinus americana L., White ash; OF, MF; F; *08-576*
¤*Fraxinus pennsylvanica* Marshall var. *subintegerrima* (Vahl.) Fernald, Green ash; OM; F; I; *08-652*
Fraxinus quadrangulata Michx., Blue ash; MF; S; *09-221*
***Ligustrum sinense* Lour., Chinese privet; OF; I; *08-682*

Onagraceae
¤*Circaea lutetiana* (L.) Asch. & Magnus subsp. *canadensis* (L.) Asch. & Magnus, Broad-leaved enchanter's nightshade; MF, IC; F; *08-670*

Orobanchaceae
¤*Conopholis americana* (L.) Wallr., American cancer-root: MF; R; *08-510*
¤*Epifagus virginiana* (L.) Barton, Beech-drops; MF, OF; O; *08-896, 09-765*

Oxalidaceae
¤*Oxalis grandis* Small, Great yellow wood-sorrel; MF; O; *08-254*
¤*Oxalis stricta* L., Common yellow wood-sorrel; CD; O; *08-384*
¤*Oxalis violacea* L., Violet wood-sorrel; OF, WB; O; *08-407*

Papaveraceae
Sanguinaria canadensis L., Bloodroot; MF; F; *08-277, 09-17*

Passifloraceae
¤*Passiflora lutea* L. var. *glabriflora* Fernald, Yellow passionflower; OF; I; *08-669*

Phrymaceae
¤*Phryma leptostachya* L., American lopseed; MF, OF; F; *08-704*

Phytolaccaceae
¤*Phytolacca americana* L., American pokeweed; OF, IC; O; *08-637*

Plantaginaceae
¤**Plantago lanceolata* L.; English plantain; CD; F; *08-463*
¤*Plantago rugelii* Decne., Blackseed plantain; CD; A; *08-586*
¤*Plantago virginica* L., Virginia plantain; CD, WB; F; *08-265*

Platanaceae
¤*Platanus occidentalis* L., American sycamore; MF; S; *08-849*

Polemoniaceae
Phlox divaricata L. var. *divaricata*, Wild blue phlox; MF; O; *08-284*
†*Phlox nivalis* Lodd. ex Sweet, Trailing phlox; CD; R; *09-74*

Polygonaceae
¤**Polygonum aviculare* L., Prostrate knotweed; CD; I; *08-723*
¤***Polygonum caespitosum* Blume var. *longisetum* (Bruijn) Steward, Asiatic smartweed; MF, IC, CD; A; *08-771*
¤*Polygonum punctatum* Elliott, Dotted smartweed; IC; O; *08-791*
¤*Polygonum scandens* L. var. *scandens*, Climbing false buckwheat; OF; I; *09-763*
¤*Polygonum virginianum* L., Jumpseed; MF, OF; F; *09-680*
¤**Rumex crispus* L., Curly dock; CD; S; *08-460*

Portulacaceae
¤*Claytonia virginica* L., Virginia spring beauty; MF, CD, OF; A; *08-136, 09-67*

Primulaceae

**Anagallis arvensis* L. subsp. *arvensis*, Scarlet pimpernel; CD; R; *08-493*

¤*Dodecatheon meadia* L., Eastern shooting-star; OF; S; *09-206*

Pyrolaceae

Chimaphila maculata (L.) Pursh, Spotted-wintergreen; WB; I; *08-569*

Ranunculaceae

¤*Actaea pachypoda* Elliott, White baneberry; MF; O; *08-754*

¤*Anemone virginiana* L., Tall thimbleweed; WB; S; *08-890*

¤*Anemonella thalictroides* (L.) Spach., Rue-anemone; MF; O; *08-276*

¤*Clematis virginiana* L., Virgin's-bower; IC; O; *08-784*

¤*Ranunculus hispidus* Michx. var. *hispidus*, Bristly buttercup; MF; O; *08-352*

¤*Ranunculus recurvatus* Poir., Hooked buttercup; MF; O; *08-281*

¤**Ranunculus sardous* Crantz, Hairy buttercup; CD; I; *09-217*

¤*Thalictrum clavatum* DC., Mountain meadow-rue; IC; R; *08-790*

Rhamnaceae

Frangula caroliniana (Walter) A. Gray, Carolina buckthorn; OF; O; *08-561*

Rosaceae

¤*Agrimonia pubescens* Wallr., Soft agrimony; MF; I; *08-872*

¤*Agrimonia rostellata* Wallr., Beaked agrimony; WB, OF; O; *08-859, 09-773*

¤*Crataegus intricata* Lange, Biltmore hawthorn; OF; R; *08-581*

¤***Duchesnea indica* (Andr.) Focke, Indian strawberry; CD; F; *08-470*

¤*Geum canadense* Jacq., White avens; OF, WB, MF; O; *08-700*

¤*Geum virginianum* L., Cream avens; OF;. I; *08-787*

¤*Porteranthus stipulatus* (Muhl. ex Willd.) Britton, Midwestern Indian physic; OF; I; *08-552*

Potentilla simplex Michx., Old-field cinquefoil; OF, WB; O; *08-372*

Prunus serotina Ehrh., Black cherry; OF, WB, MF; F; *08-622*

‡*Pyrus calleryana* Decne., Bradford pear; CD; R; *08-635, 09-09*

¤*Rosa carolina* L., Carolina rose; OF, WB; I; *08-580*

***Rosa multiflora* Thunb. ex Murr., Multiflora rose; OF; I; *08-351*

¤*Rosa setigera* Michx., Prairie rose; OF; R; *08-504*

¤*Rubus allegheniensis* Porter, Allegheny blackberry; MF, WB; O; *09-674*

¤*Rubus argutus* Link, Southern blackberry; WB, CD; F; *08-557*

¤*Rubus flagellaris* Willd., Northern dewberry; WB; O; *08-488*

¤*Rubus occidentalis* L., Black raspberry; OF, WB, IC; O; *09-761*

Rubiaceae

¤*Diodia teres* Walter, Rough buttonweed; WB; O; *08-753*

¤*Diodia virginiana* L., Virginia buttonweed; CD; O; *08-770*

¤*Galium aparine* L., Common cleavers; OF, MF; O; *08-480*

¤*Galium circaezans* Michx., Licorice bedstraw; OF, MF; F; *08-713*

¤*Galium pilosum* Aiton, Hairy bedstraw; OF, FW; O; *08-716*

¤*Galium triflorum* Michx., Fragrant bedstraw; MF, OF; O; *08-702*

¤*Houstonia caerulea* L., Spring azure bluets; CD; F; *08-262, 09-68*

¤*Houstonia purpurea* L., Broad-leaved bluets; OF; I; *09-229*

¤**Sherardia arvensis* L., Blue field madder; CD; O; *08-456, 09-224*

Salicaceae

¤*Salix nigra* Marsh., Black willow; IC; R; *08-663*

Sapindaceae

‡*Koelreuteria paniculata* Laxm., Golden rain-tree; CD; R; *08-611*

Saxifragaceae

¤*Heuchera americana* L., American alumroot; OF; I; *08-397*

¤*Saxifraga virginiensis* Michx., Early saxifrage; OF; S; *09-207*

Scrophulariaceae

¤*Aureolaria virginica* (L.) Pennell, Downy yellow false foxglove; WB; I; *08-714*

¤*Mimulus alatus* Aiton, Sharp-winged monkey-flower; MF; R; *09-766*

¤*Penstemon canescens* (Britton) Britton, Eastern gray beard-tongue; WB; S; *08-377*

¤*Penstemon digitalis* Nutt. ex Sims, Talus slope beard-tongue; IC; I; *08-487*

Scrophularia marilandica L., Eastern figwort; OF; I; *09-759*

**Verbascum blattaria* L., Moth mullein; CD; S; *08-505*

**Verbascum thapsus* L., Common mullein; CD; R; *08-728*

¤**Veronica arvensis* L., Corn speedwell; CD; F; *09-214*

¤**Veronica peregrina* L. subsp. *peregrina* Purslane speedwell; CD; O; *08-454*

¤**Veronica polita* Fr., Field speedwell; CD; R; *08-446*

¤**Veronica serpyllifolia* L., Thyme-leaved speedwell; CD; S; *09-223*

Simaroubaceae

¤***Ailanthus altissima* (Mill.) Swingle, Tree-of-heaven; OF; O; *08-845*

Solanaceae

¤*Physalis longifolia* Nutt., Long-leaved ground cherry; IC; R; *09-760*

Solanum carolinense L., Carolina horse-nettle; CD;. I; *08-613*

Staphyleaceae

Staphylea trifolia L., American bladdernut; MF; S; *08-851*

Tiliaceae

Tilia americana L. var. *americana*, American basswood; MF; I; *08-831*

Ulmaceae

Celtis occidentalis L., Common hackberry; OF; I; *08-589*

Ulmus alata Michx., Winged elm; OF; O; *08-403*

Ulmus rubra Muhl., Slippery red elm; OF, MF; F; *08-848*

Urticaceae

¤*Boehmeria cylindrica* (L.) Sw., False-nettle; MF; F; *08-924*

¤*Laportea canadensis* (L.) Wedd., Canada wood-nettle; MF; A; *08-718*

¤*Parietaria pensylvanica* Muhl. ex Willd., Pennsylvania pellitory; MF, OF; O; *08-555*

¤*Pumila pumila* (L.) A. Gray, Canada clearweed; MF; A; *08-934*

Verbenaceae

Verbena simplex Lehm., Narrow-leaved vervain; CD; R; *08-632*

¤*Verbena urticifolia* L., White vervain; IC; I; *08-779*

Violaceae

¤*Hybanthus concolor* (T.F. Forst.) Spreng., Green violet; MF; I; *08-668*

¤*Viola palmata* L., Palmate-lobed violet; OF, MF; O; *08-255*

¤*Viola pubescens* Aiton var. *pubescens*, Yellow violet; MF; S; *09-220*

Viola sororia Willd. var *sororia*, Common blue violet; CD, WB; A; *09-66*

¤*Viola striata* Aiton, Cream violet; MF; I; *09-213*

Vitaceae

¤*Parthenocissus quinquefolia* (L.) Planch., Virginia creeper; OF, MF; F; *08-627*

¤*Vitis aestivalis* Michx. var. *aestivalis*, Summer grape; OF, MF; O; *08-624*

¤*Vitis rotundifolia* Michx., Muscadine grape; MF, OF; F; *08-623*

Vitis vulpina L., Frost grape; MF; O; *09-230*

MAGNOLIOPHYTA—LILIOPSIDA

Agavaceae

¤*Manfreda virginica* (L.) Rose, False aloe; WB; R; *08-743*

Yucca filamentosa L., Spanish bayonet; OF; R; *09-679*

Alliaceae

¤*Allium canadense* L., Meadow garlic; IC, CD; O; *09-208*

¤**Allium vineale* L., Field garlic; CD; I; *08-503*

Amaryllidaceae

¤**Narcissus pseudonarcissus* L., Daffodil; CD; O; *09-11*

Araceae

¤*Arisaema dracontium* (L.) Schott, Green-dragon; MF; I; *08-642*

¤*Arisaema triphyllum* (L.) Schott subsp. *triphyllum*, Jack-in-the-pulpit; OF, MF; O; *08-244*

Commelinaceae

¤***Commelina communis* L., Asiatic dayflower; IC; O; *08-926*

Convallariaceae

¤*Maianthemum racemosum* (L.) Link, False Solomon's-seal; MF; O; *08-388*

¤*Polygonatum pubescens* (Willd.) Pursh, Hairy Solomon's-seal; MF; O; *08-283*

Cyperaceae

Carex albicans Willd. ex Spreng. var. *albicans*, White-tinged sedge; OF, WB; I; *08-357, 09-69*

¤*Carex albursina* Sheld., White bear sedge; MF; S; *09-240*

Carex amphibola Steud. var. *amphibola*, Eastern narrow-leaved sedge; MF, OF; F; *08-355*

¤*Carex blanda* Dewey, Eastern woodland sedge; MF, OF; F; *08-350, 09-241*

Carex cephalophora Muhl. ex Willd., Oval-leaved sedge; CD, WB; S; *08-370, 09-231*

¤*Carex communis* L.H. Bailey, Fibrous-rooted sedge; OF; O; *09-239*

Carex cumberlandensis Naczi, Kral, & Bryson, Cumberland sedge; MF, OF; F; *08-375, 09-237*

¤*Carex digitalis* Willd. var. *digitalis*, Slender woodland sedge; OF; I; *08-365*

¤*Carex frankii* Kunth, Frank's sedge; IC; R; *08-662*

¤*Carex glaucodea* Tuck., Blue sedge; OF, WB; O; *08-450, 09-233*

¤*Carex granularis* Muhl. ex Willd., Limestone meadow sedge; MF; S; *08-457, 09-234*

Carex hirsutella Mack., Fuzzy sedge; OF, WB; O; *08-376, 09-232*

Carex kraliana Naczi & Bryson, Kral's sedge: MF; O; *08-391*

¤*Carex laxiflora* Lam. var. *laxiflora*, Broad loose-flowered sedge; OF, MF; I; *09-238*

¤*Carex lurida* Wahlenb., Yellow-green sedge; IC; R; *08-437*

¤*Carex oligocarpa* Schkuhr ex Willd., Richwoods sedge; MF; I; *08-358*

Carex planispicata Naczi, Flat-spiked sedge; MF, OF; O; *08-404*

Carex rosea Schkuhr ex Willd., Rosy sedge; OF, MF; O; *08-446, 09-236*

Carex superata Naczi, Reznicek, & Ford, Willdenow's sedge; MF; R; *08-378*

¤*Carex texensis* (Torr. ex Bailey) L.H. Bailey, Texas sedge; MF; S; *09-242*

Carex willdenowii Schkur. ex Willd.,Willdenow's sedge; OF; O; *08-361*

¤*Cyperus echinatus* (L.) Alph. Wood, Globe flatsedge; CD; R *08-739*

Cyperus strigosus L., Straw-colored flatsedge; IC; S; *09-777*

¤*Kyllinga pumila* Michx., Low spikesedge; CD; R; *08-897*

Dioscoreaceae

¤***Dioscorea polystachya* Turcz., Chinese yam; IC; R; *09-682*

¤*Dioscorea villosa* L., Wild yam; MF, OF; O; *09-228*

Hyacinthaceae

¤***Ornithogalum umbellatum* L., Star-of-Bethlehem; CD; O; *08-268*

Iridaceae

¤*Iris cristata* Soland. ex Aiton, Dwarf-crested iris; MF; O; *08-509*

Sisyrinchium angustifolium Mill., Narrow-leaved blue-eyed grass; WB; I; *08-364*

Juncaceae

¤*Juncus effusus* L. var. *solutus* Fernald & Wiegand , Soft rush; IC; S; *08-658*

¤*Juncus tenuis* Willd., Path rush; CD; F; *08-610*

¤*Luzula echinata* (Small) F.J. Herm., Hedgehog wood-rush; FW, CD; F; *08-13, 08-271*

Liliaceae

¤*Erythronium americanum* Ker Gawl., Yellow trout-lily; MF; O; *09-16*

Orchidaceae

¤*Goodyera pubescens* (Willd.) R.Br., Rattlesnake-plantain; OF; R; *09-669*

¤*Spiranthes tuberosa* Raf., Little ladies'-tresses; WB; R; *08-842*

¤*Tipularia discolor* (Pursh) Nutt., Crane-fly orchid; OF; R; *08-870*

Poaceae

¤*Agrostis perennans* (Walter) Tuck., Upland bentgrass; OF, WB; O; *08-916*

¤*Andropogon virginicus* L. var. *virginicus*, Broom-sedge bluestem; WB, CD; O; *08-919*

¤*Arundinaria gigantea* (Walter) Muhl., River cane; MF; I; *08-434*

¤*Brachyelytrum erectum* (Schreb.) P. Beauv. var. *erectum*, Southern short huskgrass; OF, MF; O; *08-570*

¤**Bromus commutatus* Schrad., Meadow brome; CD; O; *08-462*

¤*Bromus pubescens* Muhl., Woodland brome; OF, MF; O; *08-436*

¤**Cynodon dactylon* (L.) Pers., Bermuda grass; CD; F; *08-646*

¤**Dactylis glomerata* L., Orchard-grass; CD; O; *08-471*

¤*Danthonia spicata* (L.) P. Beauv., Poverty oatgrass; WB, CD; A; *08-490*

¤*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark subsp. *fasciculatum* (Torr.) Freckmann & DeLong, Hairy panicgrass; OF, WB; F; *08-473*

¤*Dichanthelium boscii* (Poir.) Gould & C.A. Clark, Bosc's panicgrass; OF, MF; F; *08-472*

¤*Dichanthelium commutatum* (Schult.) Gould var. *commutatum*, Variable panicgrass; WB; O; *08-439*

¤*Dichanthelium dichotomum* (L.) Gould var. *dichotomum*, Forked panicgrass; MF; O; *08-433*

¤*Dichanthelium laxiflorum* (Lam.) Gould, Soft-tufted panicgrass; WB, CD; OF; F; *08-368*

¤**Digitaria sanguinalis* (L.) Scop., Hairy crabgrass; CD; F; *08-732*

¤***Eleusine indica* (L.) Gaertn., Yardgrass; CD; I; *08-729*

¤*Elymus hystrix* L., Eastern bottlebrush-grass; MF; I; *08-674*

¤*Elymus villosus* Muhl., Hairy wild rye; OF; O; *08-560*

¤*Elymus virginicus* L. var. *virginicus*, Virginia wild rye; OF; S; *08-773*

¤*Eragrostis frankii* C.A. Mey. ex Steud., Sandbar lovegrass; CD; R; *08-789*

¤***Festuca arundinacea* Schreb., Tall fescue; CD; A; *08-442*

¤*Festuca subverticillata* (Pers.) E.B. Alexeev., Nodding fescue; OF; O; *08-491*

¤*Glyceria striata* (Lam.) Hitchc., Fowl mannagrass; MF; S; *09-339*

¤*Hordeum pusillum* Nutt., Little barley; CD; I; *08-366*

¤*Leersia virginica* Willd., White cutgrass; MF, OF, IC; A; *08-781*

¤***Lolium perenne* L. var. *aristatum* Willd., Italian rye-grass; CD; S; *08-464*

¤*Melica mutica* Walter, Two-flowered melic grass; OF; O; *08-258*

¤***Microstegium vimineum* (Trin.) A. Camas, Nepalese browntop; MF, IC, OF; A; *08-928*

¤*Muhlenbergia schreberi* J.F. Gmel., Nimblewill; CD; O; *08-900*

Panicum anceps Michx., Beaked panicgrass; CD; O; *08-795*

¤*Panicum flexile* (Gatt.) Scribn., Wiry panicgrass; CD; O; *08-917*

¤*Paspalum laeve* Michx., Field beadgrass; CD; O; *08-724*

¤*Paspalum pubiflorum* Rupr., Hairy-seeded beadgrass; CD; I; *08-680*

¤**Poa annua* L., Annual bluegrass; CD; F; *09-210*

¤*Poa autumnalis* Muhl. ex Elliott, Autumn bluegrass; MF; O; *08-359, 09-203*

¤***Poa compressa* L., Canada bluegrass; CD; F; *08-447*

¤***Poa pratensis* L., Kentucky bluegrass; CD; O; *08-445*

¤*Poa sylvestris* A. Gray, Woodland bluegrass; MF; O; *09-70*

¤**Secale cereale* L., Cereal rye; CD; R; *09-215*

¤*Setaria parviflora* (Poir.) Kerguélen, Knot-rooted foxtail; CD; I; *08-751*

¤**Setaria pumila* (Poir.) Roem. & Schult., Yellow foxtail; I; *08-727*

¤***Sorghum halepense* (L.) Pers., Johnson grass; S; *08-725*

¤*Sphenopholis nitida* (Biehler) Scribn., Shiny wedge-grass; OF; I; *08-247*

¤*Tridens flavus* (L.) Hitchc., Purpletop; WB; O; *08-798*

¤**Triticum aestivum* L., Common wheat; CD;. R; *08-362*

Smilacaceae

¤*Smilax bona-nox* L., Saw greenbrier; WB, OF; O; *08-438*

¤*Smilax ecirrhata* (Engelm. ex Kunth) S. Wats., Upright carrion-flower; MF; O; *08-279*

¤*Smilax glauca* Walter, Cat greenbrier; WB, OF; I; *08-498*

Smilax hispida Raf., Bristly greenbrier; MF; I; *08-657, 09-227*

Smilax rotundifolia L., Common round-leaved greenbrier; OF, MF; O; *08-763*

Trilliaceae

¤*Trillium grandiflorum* (Michx.) Salisb., Large-flowered white trillium; MF; O; *08-275*

Uvulariaceae

¤*Uvularia perfoliata* L., Perfoliate-leaved bellwort; MF; S; *09-204*

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BOOK REVIEW

JOE MCFARLAND AND GREGORY M. MUELLER. 2009. **Edible Wild Mushrooms of Illinois & Surrounding States: A Field-to-Kitchen Guide.** (ISBN 978-0-252-07643-5, pbk.). University of Illinois Press, 1325 South Oak Street, MC-566, Champaign, Illinois 61820-6903, U.S.A. (**Orders:** orders@press.uchicago.edu, University of Illinois Press, c/o Chicago Distribution Center, 11030 South Langley Ave., Chicago, Illinois 60628, U.S.A., 1-800-621-2736, 773-702-7000 international, 1-800-621-8476 fax domestic, 773-702-7212 fax international). $24.98, 232 pp., 292 color photographs, 7" × 10".

A fantastic book on mushrooms! As a reviewer of more than 50 books I give five stars and place it at the top of my list of "must buy" books on mushrooms at a bargain-basement price. The authors merit accolades for the special content found in this book that deserves to be on the bookshelf of every mushroom enthusiast both beginner and professional alike. The design, layout, and quality color images are the "best of the best." Joe McFarland took the spectacular photographs that show exceptional depth of field and external morphological detail.

The front cover is glossy paper equivalent to 10 point, and the color images are printed on glossy, opaque paper that highlights the high resolution color images in large-sized format, sometimes two filling a page along with captions. The spine is perfect bound using glue, not stitched and sewn. This is durable enough for general use but should not be thrown in the trunk of the car or in a backpack. Nevertheless, many beginners will want to use it in the field to picture-key some of the more common edibles and poisonous mushrooms even though there are no keys to identify species.

The writing style is engaging, easy to read, humorous at times, and seems to contain a surprise each time you turn the page. If you had any doubts about collecting mushrooms, when you get through reading this book you will love to hunt, explore nature, and appreciate the incredible beauty and diversity of highly prized edible fungi that can be prepared as tasty dishes that will tantalize your palate.

There are many topical and sub-headings that require selectivity in summarizing the content. Some of the examples include discussions of "Why Forests Disappear" or a series of questions: "How can you tell if a mushroom is poisonous or edible?", "What is a mushroom?", "Why do mushrooms exist?", "Is this book really for you?", "Is it harmful to pull them out of the ground?", and "Are mushrooms good for you?" In most cases the narrative is approximately half or a full page and readily available as a brief read. Some of this information represents "golden nuggets" not found in other books.

The section about a few toxic mushrooms will be of special interest to people from Texas. Probably the most common toxic mushroom species in grassy residential lawns in the Dallas-Fort Worth area is *Lepiota molybdites*, with gills that have distinctive green spores. The large size and fairy rings that form throughout the summer, even during dry spells when triggered by ground irrigation systems, makes this a tempting morsel for small children. Another species with a Texas history is *Amanita thiersii* which was collected by Dr. Harry D. Theirs at College Station, Texas, in grassy areas. Many Amanitas are deadly poisonous and mostly occur in wooded areas. This species, however, once thought to be a restricted southern species, has apparently migrated northward where I have seen it by the hundreds on the University of Central Missouri campus and surrounding neighborhoods in grassy areas. Another toxic species, *Omphalotus illudens*, is frequently found around trees during October and November in River Legacy Parks, located in Arlington, Texas. It is one of the few examples of a mushroom that exhibits bioluminescence and glows in the dark. The gills on the underside of the cap emit an eerie bluish green color if fresh specimens are observed in a dark room (e.g. a closet) after your eyes have adapted.

"Mushrooms found with trees" is the section that includes edible mushrooms and descriptions of external morphology, habitat, and comments directly followed by look-alike species that are generally inedible or toxic. In some cases a section "In the Kitchen" gives instructions for preparation of the mushroom for various culinary uses. The list of highly prized edibles includes: *Grifolia frondosa*, *Laetiporus sulphureus*, *Pleurotus ostreatus*, *Flammulina velutipes*, *Lepista nuda*, *Hericium americanum*, *Sparassis herbstii*, *Aricularia auricular-judae*, *Armillaria mellea*, *Hypomyces lactifluorum*, *Laccaria ochropurpurea*, *Lactarius indigo*, *Morchella esculenta* (and other species of morels with stories about springtime forays (early March in Texas)), *Cantharellus cibarius* and other species of chanterelles, *Gyrosporus castaneus* and other species of boletes, *Calvatia gigantea* and *Lycoperdon perlatum* and other species of puffballs, *Agaricus campestris*, *Coprinus comatus*, and a few additional species. The only drawback to the illustrations are the color images shown as *Agaricus* sp., *Boletus* sp. *Cortinarius* sp., *Stropharia* sp., and *Xerula* sp. that should have been identified to species.

One section of the book titled "Let's Eat" has 28 recipes and advice for cooking wild mushrooms. The topical heading "Semi-dry preservation—a revolutionary process to keep mushrooms truly fresh" has "how to" information that describes here for the first time partially dehydrated frozen mushrooms—stored in a vacuum—that preserves the succulent properties of the fresh mushroom found only at seasonal times of the year. More complex recipes are given with the names of executive chefs and restaurants that serve the dish like Chicken and Lobster Sunrise or Wild Turkey and Morels, and for each recipe the ingredients and preparation are given with special sauces in some cases. There are also simple recipes that are just as scrumptious such as Black Trumpet Salad. Each recipe has a color image of the final presentation on a plate or in a bowl. Choices like Double Oyster Chowder, Chanterelle Cream Soup, Black and Bleu Morels, Beer Batter Morels with Wild Garlic Mustard Dipping Sauce, Morel Tiramisu, or Mushroom Bolognese plus other tempting mushroom dishes will have your mouth watering. This book is worth the purchase price for just the recipes alone. So everybody enjoy hunting and eating mushrooms safely and use this book as your source of information.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

PLANT COMMUNITIES OF SELECTED EMBAYMENTS ALONG THE MID- TO MID-UPPER OHIO RIVER FLOODPLAIN

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ABSTRACT

The vegetation was studied in embayment wetlands along the mid- to mid-upper Ohio River floodplain, Ohio and West Virginia. These wetlands were formed when the navigational pool elevation increased through the construction of the locks and dams for river navigation and low-lying areas adjacent to the Ohio River were inundated. The primary purpose of this study was to document and provide plant species and community information among embayment habitats. Five embayments were quantitatively sampled for woody and herbaceous species during summer and fall, of 1990 and 1991. Tree and shrub/sapling communities were evaluated through the use of relative important values. Herbaceous and aquatic communities were defined through the use of relative importance values, cluster analysis, indicator species analysis, and multi-response permutation procedure. A non-metric multi-dimensional scaling, an indirect ordination procedure, was also used to evaluate potential underlying environmental gradients. There were 257 species of vascular plants recorded from approximately 27 ha of embayment habitat. Embayment wetlands capture approximately 25 percent of the species that are common elements of the floodplain. More than half the number of species encountered across the sample area was restricted to one or two sites. This suggests that these wetlands have common elements at large broad scales with distinct elements at local scales. There were differences in herbaceous plant species, richness and diversity (*H'*) and composition among embayment sites ($P < 0.01$). Analyses of 497 vegetation plots and quadrats revealed 17 plant communities. There were five forest communities of *Acer saccharinum*, four *A. saccharinum* and one *Alnus serrulata* shrub/sapling communities. The herbaceous and aquatic plant communities were characterized by eight communities that were common to the region and four communities that were considered unique. Non-metric multi-dimensional scaling and multi-response permutation procedures results ($P < 0.01$) show that plant species were distributed according to embayment location, age and size and to a lesser extent according to species composition (non-native species, Coefficient of Conservatism, species richness and H') and wetland indicator status probability values. Our study shows that embayment wetlands hold species rich habitats and that more surveys (qualitative and quantitative) are needed to address questions that relate to biodiversity, nutrient cycling, and hydrogeomorphologic characterization.

RESUMEN

Se estudió la vegetación en pantanos de embahiamiento a lo largo de la llanura de inundación media y medio-superior de Río de Ohio, Ohio y Virginia Occidental. Estos pantanos se formaron cuando aumentó el nivel de la línea de navegación por la construcción de cierres y presas en el río y se inundaron las áreas bajas adyacentes al Río de Ohio. El propósito primario de este estudio fue documentar y proporcionar información de especies de plantas y comunidades de hábitats de embahiamiento, un hábitat único de pantano. Se muestrearon cuantitativamente cinco embahiamientos para especies leñosas y herbáceas durante el verano y otoño, de 1990 y 1991. Se evaluaron las comunidades arbóreas y arbustivas mediante el uso de valores de importancia relativa. Las comunidades herbáceas y acuáticas se definieron mediante valores de importancia relativa, análisis cluster, análisis de especies indicadoras, y de procedimiento de permutación multi-respuesta. Se utilizó también una escala multi-dimensional no-métrica y un procedimiento de ordenación indirecta para evaluar los gradientes ambientales, fundamentales y potenciales. Había 257 especies de plantas vasculares registradas en los aproximadamente 27 ha de hábitat de embahiamiento. Los pantanos de embahiamiento tienen aproximadamente el 25 por ciento de las especies que son frecuentes en las tierras inundadas. Más de la mitad del número de especies encontradas en el área de muestreo estaban restringidas a uno o dos sitios. Esto sugiere que estos pantanos tienen elementos comunes a gran escala con distintos elementos a escala local. Encontramos diferencias en la riqueza y diversidad (*H'*) de las especies herbáceas, y la composición en los lugares de embahiamiento (P <0,01). Los análisis de 497 parcelas de vegetación y cuadrados revelaron 17 comunidades vegetales. Había cinco comunidades de bosque de *Acer saccharinum*, junto con cuatro de A. *saccharinum* y una de *Alnus serrulata* arbustivas. Las comunidades herbáceas y acuáticas se caracterizaron por pertenecer a ocho comunidades que fueron comunes a la región y cuatro comunidades que fueron considerados únicas. Los resultados de los cálculos de la escala multi-dimensional no-métrica y de permutaciónes multi-respuesta (P <0,01) muestran que las especies estaban distribuidas según la ubicación del embahiamiento, la edad y el tamaño, y en menor medida por la composición en especies (especies exóticas, Coeficiente de Conservación, riqueza de especies y *H'*) y valores de probabilidad de estatus como indicadoras

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de pantanos. Nuestro estudio muestra que los pantanos de embahiamiento tienen la especie hábitats ricos en especies y que más estudios cuantitativos resolverán dudas relativas a la biodiversidad, al ciclo de nutrientes, y la caracterización de hidrogeomorfológica.

INTRODUCTION

The importance of wetlands to society has been recently, within the last 30 years, brought to the attention of policy makers (Hyberg & Riley 2009; Junk & Wantzen 2004; Mitsch et al. 2000). In 1974, the U.S. Fish and Wildlife Service (FWS) established the National Wetlands Inventory (NWI) Program (Tiner 2009). The charge of this program was to conduct a nationwide inventory of wetlands in order to provide FWS biologists with information on the distribution of wetlands for wetland conservation efforts (Tiner 2009). In 1986, the Federal Government mandated, through the Emergency Wetlands Resources Act, that the FWS complete mapping and digitizing of wetlands data for the Nation, and to distribute and archive the data (Dahl et al. 2009). The NWI program developed a wetland classification system (Cowardin et al. 1979) which is the current federal standard of the USFWS and the Federal Geographic Data Committee (Tiner 2009). The original purpose of the National Wetlands Inventory program was to map, on a large scale, our nations' wetlands. The current products of the program are a wetlands geospatial database that can be used to generate maps and statistics about the status of the Nation's wetlands and the other products include national wetlands status and trends reports (Tiner 2009).

Overall the NWI program has been an incredible success but there are limitations. According to the 2009 NWI Status Report, the most frequent complaint about the program is that the data are too old for many applications and that the NWI data should be updated more frequently (Tiner 2009). Further, there is the issue of incomplete data, only 61% of the nation's wetlands have been mapped and entire wetland areas and wetland margins were or are not detected with the remote sensing that took place in the 1970s and 1980s (Cowardin & Golet 1995).

The regulation of rivers and natural water-ways for flood control, agriculture and urban development, and river navigation affects the hydrological connectivity or flood pulse of the river with floodplain and riparian wetland ecosystems (King et al. 2009; Reid and Brooks 2000). Specifically, the flood pulse concept (Junk et al. 1989) states that the dynamic nature of the hydro-geomorphological condition is the primary force that is responsible for the existence, productivity, and interactions of biota in river-floodplain systems (Junk et al. 1989; Junk 1999; Junk & Wantzen 2004).

The Ohio River is formed by the confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania. Navigation on these rivers has evolved from the use of bark and dugout canoes of the Native Americans to mass river transportation by barges. In its original condition, navigation along the Ohio River was difficult and hazardous due to natural fluctuations of the river throughout the year (US Army Corps of Engineers 1979). The first river modernization project, started in 1955, replaced nineteen moveable locks and dams. The purpose of the modernization project was to convert river navigation from a local commerce to an 'interstate highway' (Johnson 1992). The hydrology of the river has changed from an open channel to a series of 'reservoirs' between dams. The water depth increased profoundly in low-lying areas adjacent to the river. These changes in the river channel, flow and navigation water pool elevation resulted in the loss of many wetlands but it also created wetlands or embayments. Originally these areas were periodically inundated throughout the growing season but after the modernization projects they were permanently flooded. Embayments are most often formed along permanent or intermittent stream channels.

Although the U. S. Fish and Wildlife Service (2002) identified approximately 2225 ha of undisturbed embayments within its' planning area of the Ohio River Island Wildlife Refuge and the agency recognizes that embayments are significant habitats for fish, mussels, amphibians and reptiles, waterfowl and mammals. Embayment plant communities have not been inventoried except for a few isolated studies performed through agents of the U.S. Army Corps of Engineers. Koryak (1978) examined a recently formed embayment after the completion of the Hannibal Locks and Dam. The potential for embayment aquatic and emergent plant community development is high and there is strong evidence to indicate that embayments in older navigational pools support productive plant communities with high biological diversity (Koryak 1978). There is little known about embayment plant communities along the Ohio River floodplain other than large scale wetland mapping by the National Wetlands Inventory Program. The purpose of this study was to survey and identify embayment plant communities, assess potential gradients, and to provide a local and regional characterization of embayment that typically occur along the mid to mid-upper Ohio River floodplain, River.

METHODS AND MATERIALS

Study Site Description

Potential study sites were selected from U.S.G.S. and U.S. Army Corps of Engineers navigational topographical maps (U.S. Army Corps of Engineers 1966, 1978), Ohio River Navigational Charts (U.S. Army Corps of Engineers 1989), and color aerial photographs (obtained from the U.S. Army Corps of Engineers, Huntington, WV). These resources were used to assess wetland size, type, associated habitat, disturbance levels, and ease of access (Ely 1993). Each study site was delineated from the surrounding uplands based on hydrological conditions, vegetation, soils, and slope.

The study sites (embayments) are located in the Greenup and Gallipolis or R.C. Byrd navigational pools (Fig. 1) between river km 434 and 549. The 115 km stretch of the Ohio River occurs between Gallipolis Ohio and Greenup Kentucky. The original Gallipolis Locks and Dam was a part of the 46 movable lock and dam series and maintained a maximum navigational water depth of 2.75 m (Shows & Wooley 1989). This was replaced with non-removable roller-gates that increased navigational pool elevation by 5.8 m (Johnson 1992; Jones 1914). Sites selected in this navigation pool were at least fifty-three years old in 1991 and include Chickamauga Creek (river kilometer 434, 8.3 ha), Crab Creek (river kilometer 444, 2.1 ha) and Teen's Run (river kilometer 449, 4.0 ha).

The current Greenup Locks and Dam replaced four of the original 46 dams and it was operational in 1962 (Johnson 1992). This increased the navigational depth more than six meters (Jones 1914; US Army Corps of Engineers 1979). Sites located in the Greenup navigational pool include Franklin's or Chandler's Run (river kilometer 549, 3.2 ha), and Ginat's Run (river kilometer 546, 9.3 ha), (Fig. 1) and these sites were at least twenty-nine years old at the time of the study.

The study area lies within the mixed mesophytic forest of the Allegheny Plateau (Braun 1950) and are located within the Western Allegheny Plateau of the Eastern Temperate Forest Ecoregions of North America (Alan et al. 2007a, 2007b). Three of the five study sites are located within the Monongahela Transition Zone and the other two sites occur in the Ohio-Kentucky Carboniferous Plateaus with elevations ranging from 157 to 165 m above sea level. Mixed mesophytic and mixed oak forests were the original forest of the Western Allegheny Plateau (Alan et al. 2007a, 2007b). Today, urban, residential, and agriculture development dominate the floodplains. The average January and June temperatures are 1.6°C and 24°C, respectively (Alan et al. 2007a, 2007b). Braun (1950) described the bottomland hardwood forest of the mixed mesophytic region as an *Acer saccharinum* L. (silver maple) and *Populus deltoides* Bartram ex Marsh. (eastern cottonwood) community with contributions of *Salix* spp., *Platanus occidentalis* L. (sycamore), *Liquidambar styraciflua* L. (sweetgum), and *Betula nigra* L. (river birch). It is believed that these five study sites represent the features of a typical embayment for this region of the Ohio River floodplain.

Sampling

Each embayment site was visited monthly during summer and fall of 1990 and 1991. The vegetation at each embayment site was divided into three layers or strata: trees (overstory), sapling and shrub (understory), and herbaceous (groundcover). Submerged aquatic plants were sampled with the herbaceous cover because they often integrate. In addition, trees, woody saplings and shrubs, and ground cover species were treated as separate quantitative studies. Sampling plots in the tree and shrub and sapling layers were randomly placed while a stratified random sampling of herbaceous plots was used (see below). Original identification procedures followed Gleason and Cronquist (1991), Strausbaugh and Core (1978), Cusick and Siblerhorn

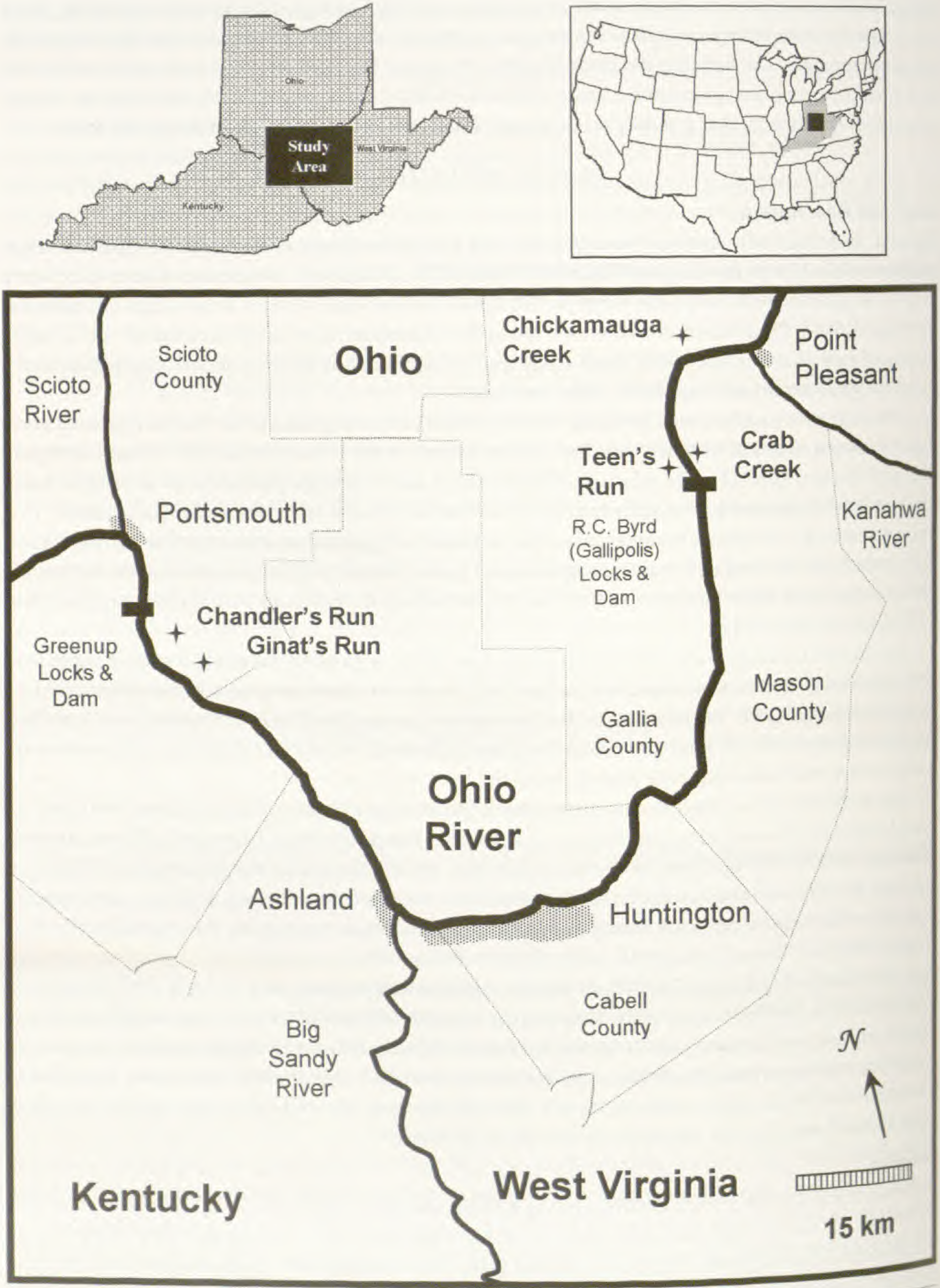
Ohio
Study Area
West Virginia
Kentucky
Chickamauga Creek
Point Pleasant
Scioto County
Ohio
Scioto River
Crab Creek
Teen's Run
Portsmouth
R.C. Byrd (Gallipolis) Locks & Dam
Kanahwa River
Chandler's Run
Ginat's Run
Greenup Locks & Dam
Mason County
Gallia County
Ohio River
Ashland
Huntington
Cabell County
Big Sandy River
N
Kentucky
West Virginia
15 km

Fig. 1. Map of study site locations along the mid- to mid-upper Ohio River floodplain, Gallia County (Chickamauga Creek) and Scioto County (Chandler's Run, Ginat's Run and Teen's Run) Ohio and Mason County (Crab Creek) West Virginia.

(1977), Britton and Brown (1970), but the current nomenclature follows the Flora of North America North of Mexico (Flora of North America Editorial Committee 1993+). Voucher plant specimens were collected and are deposited in the Marshall University Herbarium, Huntington, WV (MUHW; Ely 1993).

Trees in this study were defined as woody plants that were equal to or greater than 8.0 cm in diameter at breast height (1.4 m) or DBH. Trees were identified to species and DBH recorded to the nearest tenth of a centimeter. Saplings and shrubs were defined as woody plants less than 8.0 cm DBH but equal to or greater than 1.0 m tall. Their height was visually estimated to the nearest meter and recorded.

Herbaceous species were composed of herbaceous plants, woody plant seedlings less than 1.0 m tall, and species of woody vines. Woody plants that exceeded 1.0 m in height but were too dense and/or prostrate to record in the usual manner were also included. Such species included in this category were *Rosa palustris* Marsh. (swamp rose) and *Cornus amomum* Mill. (silky dogwood).

Herbaceous plot sampling occurred along two to five transect lines at each study site. The number and placement of transect lines depended on embayment size. For example, the larger sites were evaluated with four to five 100 m transect lines whereas smaller sites were evaluated with two. In general, transect lines reached from the edge of the wetland to open water. Plots measuring 100 m^2 were placed along each transect line. Eight 1 m^2 quadrats were randomly selected within each 100 m^2 plot. For each species, the percent cover values were visually estimated and recorded in each quadrat. Species area curves were established and used as a guide to obtain an adequate number of plots.

Data Analysis

Overstory, understory, and herbaceous communities were assessed through the calculation of relative importance values. The overstory DBH values were converted to basal area (BA) for each species. Density, frequency, BA (overstory), estimated height (understory) values were used in determining relative importance values. Relative importance values for herbaceous plant species was derived from relative frequency of occurrence and percent estimated cover values for each taxon.

Herbaceous species percent cover values were converted to a modified Daubenmire cover class scale (Daubenmire 1959). The midpoint values of each cover class were used in subsequent analyses. The seven cover classes were: 1: 0 to < 1%, 2: 1 to 4%, 3: 5 to 24%, 4: 25 to 49%, 5: 50 to 74%, 6: 75 to 94% and 7: 95 to 100%.

Herbaceous species diversity was evaluated using species richness, evenness (Pielou 1966) and Shannon-Weiner (Shannon 1948) indices. Index values were calculated based on a quadrat by quadrat basis and means and standard errors were calculated for each study site. Coefficient of Conservatism (Wilhelm & Ladd 1988) and wetland indicator status probability values (Reed 1988) were determined for each native species. Because the Coefficient of Conservatism values for the same species differed significantly ($P < 0.05$) between the states of Ohio and West Virginia, average values among the two states were used in order to make the data comparable. Non-native species were also identified among embayment sites. The indices, WI, CC, cover values, non-native cover values were used to assess the uniqueness and similarities of each site and to identify potential gradients. In addition, herbaceous species and species composition among study sites were compared using Multi-Response Permutation Procedures (MRPP) and indicator species were calculated using Indicator Species Analysis (ISA).

Herbaceous species cover data were classified into groups using agglomerative hierarchical cluster analysis and potential gradients were identified with Non-metric Multidimensional Scaling, NMS, an indirect ordination procedure. In order to define groups, we calculated a Cluster Analysis with Sorensen's distance measure (Sorensen 1948) based on the midpoints of the Duabenmire cover class data using flexible beta with ß = -0.25 in the program PC-ORD (McCune & Mefford 1999). Although Soresen's distance measure has been under scrutiny (Legendre & Legendre 1998) for its' use with community data analysis, our justification for use is that it resulted in the least amount of chaining among sample plots with cluster analysis and the lowest stress with the NMS ordination (see below). Chaining is the phenomenon of the addition of single sample quadrats to existing groups that result in undefined clusters. Indicator species for each of the cluster analysis defined groups were identified using Indicator Species Analysis, ISA (see below). The wetland probability indicator status (Reed 1988), WI, was determined for each native species belonging to each group or community as defined by cluster analysis. The categories include Obligate+, Obligate, Obligate-, Facultative Wet+, Facultative Wet, Facultative Wet-, Facultative+ Facultative, Facultative-, Facultative Upland+, Facultative Upland, Facultative Upland- or Upland. In addition, habitat (aquatic, mudflat, or emergent) and dominant species height (tall, medium or short) were determined for each group.

An ISA was used to determine the statistically significant indicator species (as defined by indicator value or IV) in each cluster grouping. This procedure combines information on abundance and frequency data to determine the 'faithfullness' of a particular species to a particular group or cluster. Faithfulness can be defined as the constancy of presence or how likely a specific species will be found in a cluster group (McCune & Grace 2002). In order to explore the relationship of herbaceous species and sample data to potential environmental gradients we use Non-metric multi-dimensional scaling (NMS). Although direct measurement of environmental variables was not a part of this study, we used an indirect approach using Species Richness, Shannon-Wiener Diversity (*H'*), embayment age and river location (expressed in river kilometer), species cover (total and non-native), wetland indicator status probability values (Reed 1988) and Coefficient of Conservatism values (Wilhelm & Ladd 1988; Rentch & Anderson 2006; Andreas et al. 2004). Strengths of association between these values and the NMS axes scores were calculated using Kendall's Tau, τ, values (Zar 2010). Joint biplots were constructed from the ordination scores and τ values.

All NMS analyses were conducted using Sorensen's distance measure. Monte-Carlo tests were used to determine statistical significance of each NMS solution. The percent of variation represented and the coefficient of determination for each axis, the final stress value, and associated *P*-values are reported.

Cluster analysis, NMS, MRPP and ISA were performed using PC-ORD version 4.41 (McCune & Mefford 1999). An alpha (α) or significance level of 0.05 was used for NMS and ISA. A Bonferroni correction to the α-level (Sokal & Rohlf 1995) was made for the MRPP based on the number of embayment sites.

RESULTS

Species Composition

A total of 257 vascular plants species was encountered among study sites during the course of the study period; there were 3 fern and fern allies, 84 Monocots and 170 Dicots representing 77 families and 201 genera. The largest number of species occurred in the Poaceae (28, 10.85%), Cyperaceae (27, 10.47%), and Asteraceae (25, 9.69%). Polygonaceae (11, 4.26%) and Fabaceae (9, 3.49%) had a limited contribution to species numbers. The number of non-native species across sites was 40 (16.72%). The average Coefficient of Conservatism value was 3.51 (± 0.02).

The number of species encountered within and outside of sampling plots at each embayment site ranged from a low of 119 (Teen's Run) to a high of 157 (Ginat's Run). Ginat's and Teen's Run had the largest number woody species encountered in the tree (11 each) and sapling and shrub communities species (n = 13 and 14, respectively) during this study (Table 3).

Herbaceous species richness and diversity was significantly higher at Chickamauga Creek ($\bar{X} = 3.35 \pm 0.09$) than other sites (Fig. 2i, ii). There were no differences in Species Richness among remaining embayments. Ginat's Run had a significantly higher diversity value ($\bar{X} = 1.10 \pm 0.06$) than Teen's Run ($\bar{X} = 1.00 \pm 0.04$), but there were no differences among the remaining embayments (Fig. 2ii). Although there were no differences in total cover between Chickamauga ($\bar{X} = 193.88 \pm 9.47$) and Crab Creek ($\bar{X} = 176.94 \pm 9.09$), both sites had higher values than the remaining study sites (Fig. 2iii). Coefficient of Conservatism was lowest at Chickamauga Creek ($\bar{X} = 3.35 \pm 0.09$) while Crab Creek ($\bar{X} = 3.59 \pm 0.04$) and Chandler's Run ($\bar{X} = 3.56 \pm 0.10$) were the highest (Fig. 2iv). The mean wetland probability values among sites were highest at Crab Creek ($\bar{X} = 95.43 \pm 0.62$) and Chandler's Run ($\bar{X} = 94.04 \pm 0.73$) (Fig. 2v) while Chickamauga Creek ($\bar{X} = 84.49 \pm 1.16$) was the lowest. Both Chandler's ($\bar{X} = 19.42 \pm 3.99$) and Teen's Run ($\bar{X} = 18.13 \pm 3.28$) had the highest non-native species cover (Fig. 3vi) and Ginat's Run ($\bar{X} = 0.46 \pm 0.20$) had the lowest non-native.

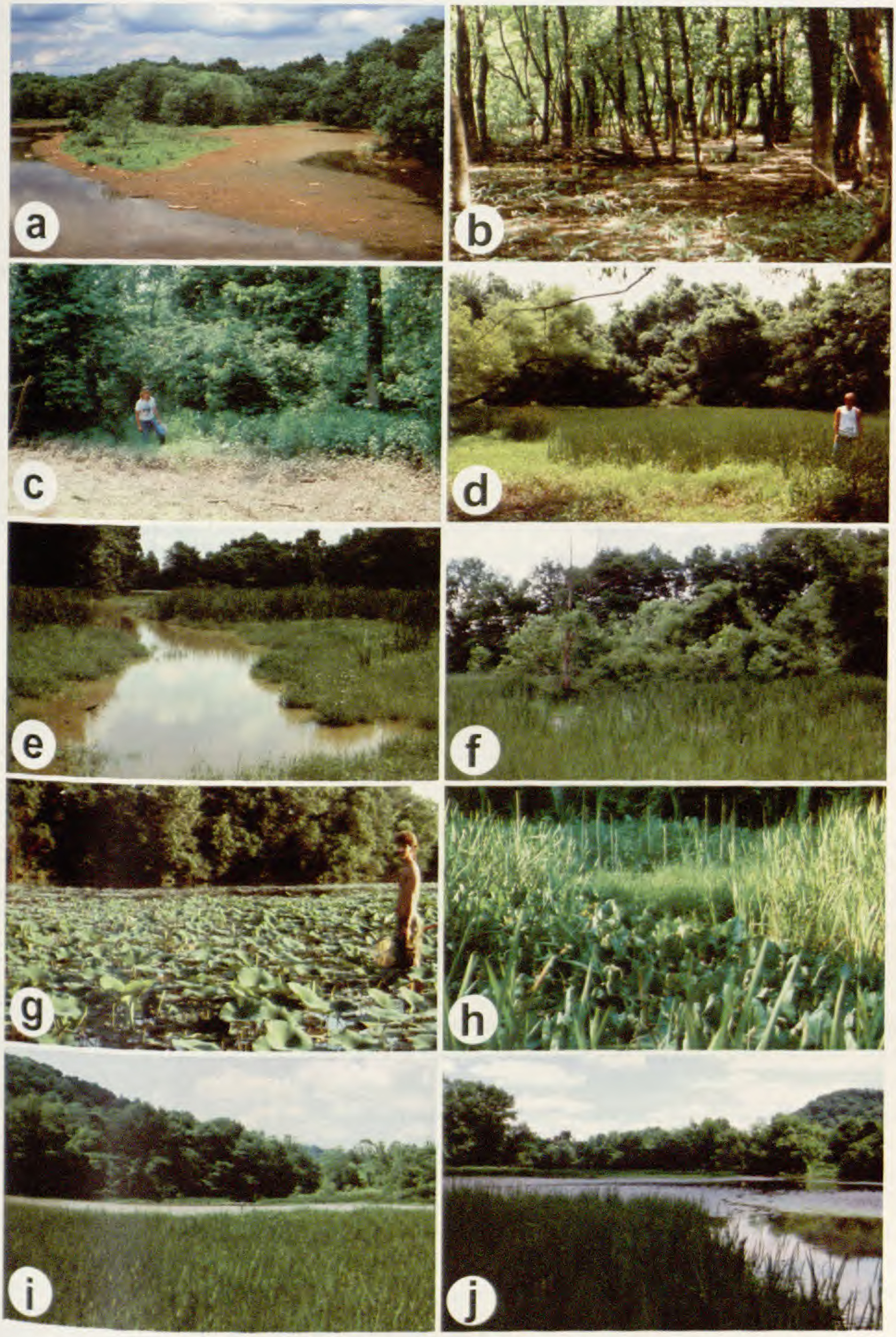

FIG. 2. Embayment wetland habitat types. Chickamauga Creek embayment during the spring (**a**) and *Acer saccharinum* bottomland hardwood forest (**b**); Crab Creek open oxbow, mid-summer (**c**) and early fall (**d**); Chandler's Run early summer (**e**,**f**); Ginat's Run *Nelumbo lutea* bed (**g**) and emergent marsh (**h**); and, Teen's Run early summer (**i**) and Autumn (**j**).

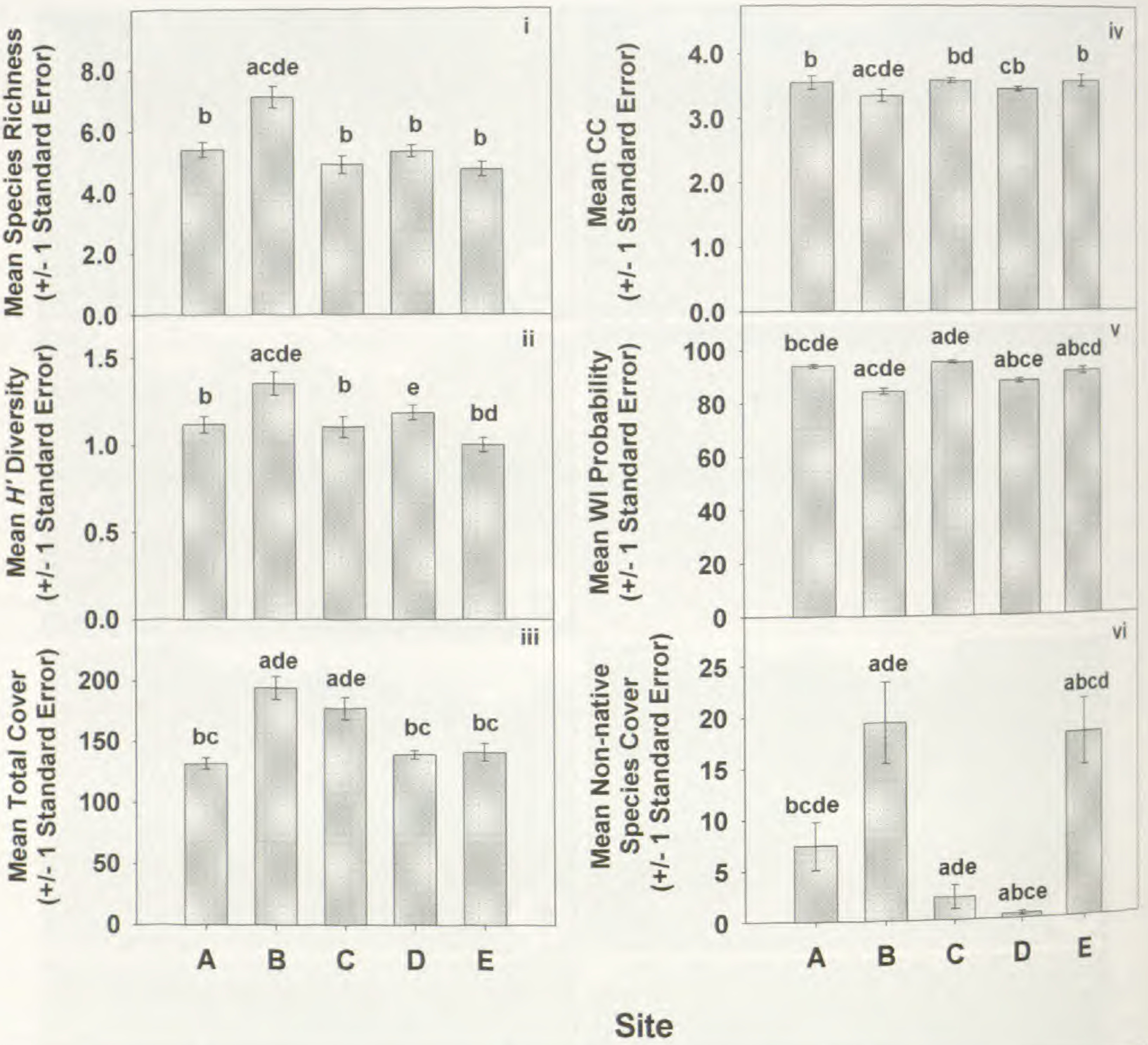

Fig. 3. Mean (± 1 standard error) species richness, diversity, species cover, Coefficient of Conservatism, Wetland Indicator Status probability values, and non-native species cover for Embayment sites along the mid- to mid-upper Ohio River floodplain. Different lower case letters indicate significant differences and A = Chandler's Run, B = Chickamauga Creek C = Crab Creek, D = Ginat's Run, and E = Teen's Run.

Regional Community Composition and Structure

The bottomland hard wood forest across the study area was dominated by *Acer saccharinum* with contributions of *Fraxinus pennsylvanicum* Marsh. (green ash), *Platanus occidentalis*, and *Salix nigra* Marsh. (black willow), and a variety of upland and wetland species (Table 1). The sapling layer consisted of *Acer saccharinum* and *Fraxinus pennsylvanicum* (Table 2) while the shrub layer was characterized by *Cephalanthus occidentalis* L. (common buttonbush), *Cornus amomum*, *Alnus serrulata* (Aiton) Willd. (hazel alder), and *Lindera benzoin* (L.) Blume (northern spicebush) (Table 2). All tree, sapling and shrub communities consisted of native elements of the region except for one individual of *Ligustrum vulgare* L. (European privet) occurred at Teen's Run. The herbaceous plant community consisted of *Sparganium eurycarpum* Engelm. (broadfruit bur-reed), *Leersia oryzoides* (L.) Sw. (rice cutgrass), *Sagittaria latifolia* Willd. (broadleaf arrowhead), *Persicaria sagittata* (L.) H. Gross (arrow-leaf tearthumb), and *P. punctata* (Ell.) Small (dotted smartweed) (Table 3). The floating aquatic community is characterized by *Lemna minor* L. (duckweed) , *Spirodela polyrrhiza* (L.) Schleiden (greater duckweed) and *Leersia oryzoides* while the submerged aquatic layer was comprised of *Myriophyllum spicatum* and *Najas minor* All. (water-nymph) with interspersed *Elodea nuttalli* (Planchon) St. John (free-flowered water-weed).

Table 1. Basal area (BA) and relative importance values (RIV) of the Tree strata among selected embayment sites and at the regional scale.

	Chickamauaga Creek		Crab Creek		Chandler's Run		Ginat's Run		Teen's Run		Regional	
Species	**BA**	**RIV**	**BA**	**RIV**	**BA**	**RIV**	**BA**	**RIV**	**BA**	**RIV**	**BA**	**RIV**
Acer negundo	1343.8	4.5	95.0	3.8	285.1	9.2	190.1	2.4	44.4	1.5	391.7	4.3
Acer saccharinum	81674.8	64.0	11217.8	48.7	42344.5	62.9	30819.3	39.5	15643.8	47.7	36340.0	52.5
Betula nigra							95.0	2.0			19.0	0.4
Carya laciniosa							1295.1	3.1			259.0	0.6
Fraxinus pennsylvanica	3721.2	7.5	2558.8	20.4	1333.6	7.0	9191.7	19.8	467.4	3.6	3454.5	11.7
Liquidambar styraciflua							3024.6	7.0			604.9	1.4
Nyssa sylvatica							95.0	2.0			19.0	0.4
Platanus occidentalis	7470.7	6.9	2503.0	15.1	1693.3	6.8	2325.6	7.0	4455.2	18.3	3689.6	10.8
Populus deltoides	804.3	2.1							59.4	1.4	172.7	0.7
Robinia pseudoacacia							1361.9	7.7	425.4	2.6	357.4	2.1
Salix nigra	11431.5	8.7	1349.3	8.3	2833.7	14.2	95.0	2.0	2104.5	11.9	3562.8	9.0
Ulmus rubra	665.2	6.3	95.0	3.8			3183.2	7.5	459.5	7.5	880.6	5.0
Cercis canadensis									22.2	1.3	4.4	0.3
Catalpa speciosa									103.8	2.9	20.8	0.6
Prunus serotina									59.4	1.4	11.9	0.3
Total:	107111.4	100.0	17819.0	100.0	48490.2	100.0	51676.5	100.0	23844.8	100.0	100.0	100.0

Local Community Composition and Structure

Tree, Sapling and Shrub and Herbaceous Communities.—The tree community at the site level reflected similarities in species composition and importance that was observed at the regional scale with subtle differences. Although all sites were dominated by *Acer saccharinum*, *Platanus occidentalis* was a subdominant at Crab Creek and both *P. occidentalis* and *Fraxinus pennsylvanicum* were also important at Teen's Run (Table 1).

The sapling and shrub communities varied more than the tree community among sites. *Acer saccharinum* was an important sapling and shrub species among all sites except for Ginat's Run. *Alnus serrulata* dominated the community at Ginat's Run and was a sub-dominant at Chandler's Run. *Fraxinus pennsylvanicum* dominated the sapling and shrub community at Crab Creek and was a subdominant at Chickamauga Creek (Table 2). *Cornus amomum* was dominant and subdominant at Teen's Run and Chickamauga Creek, respectively. *Lindera benzoin* was an important understory tree at Crab Creek. *Amorpha fruiticosa* L. (false indigo) was of minor importance at Chandler's Run (Table 2). Five communities were identified among embayment sites. Similar to the tree community, Ginat's and Teen's Run's the sapling and shrub community had the highest species represented among all sites, 13 and 14, respectively.

The MRPP for the testing of differences in herbaceous species cover and sample data were moderately to well defined among embayment sites ($T = -83.12$, $\delta =$ of 0.39, $A = 0.21$, $P < 0.01$). The herbaceous plant community consists of *Sparganium eurycarpum*, *Leersia oryzoides*, *Sagittaria latifolia*, *Persicaria sagittata*, and *Persicaria punctata* (Table 3). The floating aquatic community would be characterized by *Lemna minor* / *Spirodela polyrrhiza* while the submerged aquatic layer consisted of *Myriophyllum spicatum* and *Najas minor* that was interspersed with *Elodea nuttalli*. Relative importance and indicator values indicated that the herbaceous community was the most variable community at the site level. The emergent marsh community at Chickamauga Creek was characterized by *Persicaria punctata*, *Sagittaria latifolia*, *Commelina virginica* L. (dayflower), *Carex tribuloides* Wahlenb., *Leersia oryzoides*, and *Nelumbo nucifera* Gaertner, Crab Creek emergent herbaceous community was dominated by *Sparganium eurycarpum*, *Leersia oryzoides*, and *Sagittaria latifolia*. One floating and emergent plant community consisting of *Lemna minor* L. (lesser duckweed) / *Spirodela polyrrhiza* was found in an old oxbow channel at Crab Creek. Overall the herbaceous layer at Chandler's Run was characterized by a *Persicaria sagittata*, *Leersia oryzoides*, *Sparganium eurycarpum*, *Hibiscus moscheutos* L. (crimsoneyed rosemallow), *Persicaria punctata*, and *Sagittaria latifolia* emergent community (Table 3). Ginat's Run's emergent marsh consisted of *Leersia oryzoides*, *Sagittaria latifolia*, *Sparganium eurycarpum*, *Persicaria sagittata*, *Onoclea* sensibilis L. (sensitive fern), and *Juncus effusus* L. (soft rush). *Sparganium eurycarpum*, *Sagittaria latifolia*, and *Iris pseudacorus* L. (yellow flag) characterized Teen's Run herbaceous community.

Classification of Herbaceous Plant Communities

The results of the cluster analysis and indicator species analysis (Fig. 4) show twelve defined groups with 22% of the information (Wishart 1969) remaining at that level. The result of the Indicator Species Analysis (ISA) was significant ($P < 0.05$). ISA indicator species values or IV are reported along with the Relative Importance Values (RIV) for each defined group or community (Table 4). The wetland indicator status, height, embayment site, and number of quadrats, n, for each community are also included.

There were two obligate+ aquatic communities consisting of a submerged community and a short emergent community. The submerged community was dominated by *Najas minor* and *Myriophyllum spicatum* and these species were indicators (Table 4, Fig. 4-community G). This community was only observed at Chandler's Run (n = 8). The short emergent community (Table 4, Fig. 4, community H) with a dominant and indicator species of *Nelumbo lutea* was interspersed with the submerged aquatic *Myriophyllum spicatum*. Similar to the former community, this community was observed only at one embayment, Ginat's Run (n = 6).

There were three obligate- wetland communities that consisted of one medium and two tall emergent communities. The medium emergent community was dominated by *Persicaria punctata* and *P. hydropiperoides* (Michx.) Small (swamp smartweed) and these species were the top indicators for that community (Table 4, Fig. 4, community A). This community was distributed at Chandler's Run (n = 13), Chickamauga Creek (n =

TABLE 2. Density (D) per hectare and relative importance values (RIV) of the sapling and shrub strata among selected embayment sites and at the regional scale.

	Chickamauaga Creek		Crab Creek		Chandler's Run		Ginat's Run		Teen's Run		Regional	
Species	D	RIV	D	RIV	D	RIV	D	RIV	D	RIV	D	RIV
Acer negundo	1.4	3.0	34.3	6.4	3.4	8.5	3.8	2.5	142.4	4.9	37.1	5.1
Acer saccharinum	101.9	25.6	128.7	15.9	58.2	48.1	20.0	3.6	988.5	21.6	259.5	22.9
Alnus serrulata	8.3	3.7			34.2	26.0	704.1	67.5			149.3	19.4
Amorpha fruticosa					3.4	7.6	10.0	1.7			2.7	1.9
Asimina triloba			17.2	4.1							3.4	0.8
Betula nigra			8.6	2.7			2.5	1.3			2.2	0.8
Carya laciniosa									67.0	2.8	13.4	0.6
Cephalanthus occidentalis	246.4	20.8							1.2	1.2	49.5	4.4
Cornus amomum	6.9	13.5					11.3	2.8	1097.4	21.7	223.1	7.6
Fraxinus pennsylvanica	59.2	14.5	369.1	33.9			11.3	1.6	75.4	4.0	103.0	10.8
Juglans nigra									8.4	0.8	1.7	0.2
Ligustrum vulgare									100.5	4.3	20.1	0.9
Lindera benzoin			240.3	16.1					259.7	5.5	100.0	4.3
Platanus occidentalis	2.8	3.3	25.8	6.6			1.3	1.2	125.7	5.6	31.1	3.4
Robinia pseudoacacia							37.6	4.0	8.4	0.8	9.2	1.0
Salix nigra	4.1	9.2	34.3	6.7	6.9	9.8	17.5	5.7	1218.8	20.5	256.3	10.4
Sambucus nigra ssp. *canadensis*							3.8	1.3			0.8	0.3
Sassafras albidum							5.0	2.5	8.4	0.8	2.7	0.7
Tilia americana var. *heterophylla*	1.4	2.3									0.3	0.5
Ulmus rubra	2.8	3.1	51.5	7.6			3.8	4.3	150.8	5.6	41.8	4.1
Total:	435.0	100.0	909.7	100.0	106.1	100.0	831.8	100.0	4252.4	100.0	1307.0	100.0

TABLE 3. Relative indicator values (IV) and importance values (RIV) of groundcover among embayment sites.

	Chandler's Run		Chickamauga Creek		Crab Creek		Ginat's Run		Teen's Run		Regional
Species	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**RIV**
Apios americana			14.4	0.30							0.00
Bidens frondosa					20.5	0.43					0.43
Bidens tripartita					35.7	0.89					0.89
Boehmeria cylindrica			18.8	0.75		0.48				0.30	0.78
Carex lurida										0.42	0.42
Carex tribuloides			35	1.36						0.44	0.44
Carex vulpinoidea									11.5	0.35	0.35
Commelina communis			21.5	0.39							0.00
Commelina virginica			41.2	1.48							0.00
Cornus amomum									7.7	0.45	0.45
Cuscuta gronovii	10.1	1.0						1.07			3.05
Cyperus esculentus			13.6					0.69			0.69
Cyperus odoratus				0.55							0.00
Eleocharis ovata			26.2	0.89							0.00
Elymus villosus	24.1	0.94									1.88
Galium tinctorium		0.9				0.22	19	1.48		0.62	4.10
Hibiscus moscheutos	34	2.3						1.13			5.77
Impatiens capensis	10.7	1.0				0.38		0.46		0.32	3.14
Iris pseudacorus									25.7	1.48	1.48
Juncus effusus							34.7	2.33		0.57	2.90
Justicia americana									17.3	0.63	0.63
Leersia oryzoides		2.7		1.07	27.2	2.25		5.32		0.32	13.27
Leersia virginica		0.3									0.64
Lemna minor/Spirodela polyrrhiza					10.7	0.38					0.38
Ludwigia palustris			16.9	0.31							0.00
Lindernia dubia				0.39	24.8	0.95					0.95
Myriophyllum spicatum		0.3									0.64
Najas minor		0.5									1.04
Nelumbo lutea							5.2	0.46			0.46
Nelumbo nucifera			18.5	0.90							0.00
Onoclea sensibilis						0.17	25.7	2.40			2.57
Dichanthelium clandestinum	15.1	0.5									1.00

Table 3. continued

	Chandler's Run		Chickamauga Creek		Crab Creek		Ginat's Run		Teen's Run		Regional
Species	IV	RIV	IV	RIV	IV	RIV	IV	RIV	IV	RIV	RIV
Persicaria pensylvanica			21.5	0.33							0.00
Persicaria punctata		2.2	38.5	2.03		0.64				0.77	5.81
Persicaria sagittata	36	3.7		0.77		0.65		2.40		0.54	10.93
Sagittaria latifolia		0.5		1.57		1.27		3.14	25.5	3.73	9.14
Saururus cernuus				0.42							0.00
Schoenoplectus tabernaemontani				0.56		0.16		0.75			0.91
Scirpus cyperinus								0.66			0.66
Sparganium eurycarpum		2.4			24.8	2.75		2.90		5.00	15.39
Typha latifolia							21.2	1.17		0.36	1.53
Xanthium strumarium			26.2	0.50							0.00
Subtotal:		19.22		14.57		11.62		26.36		16.30	92.72
Other Taxa (65 species):		2.18		4.11		0.96		1.18		4.00	7.28
Total:		21.40		18.18		12.58		27.54		20.30	60.42

TABLE 4. Significant ($p < 0.001$) indicator values (IV) and relative importance values (RIV) of cluster analysis defined herbaceous plant communities among embayment sites. Indicator

	Community											
	A		B		C		D		E		F	
Taxa	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**	**IV**	**RIV**
Ammannia coccinea											15.5	0.27
Apios americana							23.9	0.30				
Arthraxon hispidus							14.7	0.24				
Asclepias incarnata	11.9	0.12										
Boehmeria cylindrica		0.08					26.4	0.59		0.06		
Carex stipata					18.2	0.05						
Carex tribuloides							61.0	1.43		0.06		
Commelina communis	28.4	0.24										
Commelina virginica							60.0	1.41				
Cornus amomum									42.1	0.45		
Cuscuta gronovii		0.19	22.2	1.21		0.11		0.26				
Cyperus odoratus											18.9	0.80
Elymus villosus		0.05	17.5	0.60								
Galium tinctorium		0.23		0.47		0.16				0.11		
Hibiscus moscheutos		0.22	39.8	1.08		0.08						0.30
Impatiens capensis		0.05		0.42						0.11	16.7	0.89
Iris pseudacorus						0.03			96.9	1.28		
Juncus effusus										0.10		0.46
Justicia americana												
Laportea canadensis			13.9	0.25								
Leersia oryzoides		0.13		1.38		0.12		0.54				0.93
Lindernia dubia											16.7	0.29
Ludwigia palustris												
Lysimachia nummularia									18.5	0.19		
Myriophyllum spicatum												
Najas minor												
Nelumbo lutea												
Nelumbo nucifera											20.7	0.90
Onoclea sensibilis				0.52	75.0	0.72		0.17				0.29
Dichanthelium clandestinum		0.05	14.0	0.37								
Persicaria hydropiperoides	25.8	0.19										
Persicaria pensylvanica							25.4	0.28				
Persicaria punctata	55.5	1.31		0.79				1.03				0.55
Persicaria sagittata		0.70	38.3	3.20		0.29		0.92		0.09		0.50
Sagittaria latifolia		0.09		0.57		0.15		1.61		0.37		0.65
Schoenoplectus tabernaemontani		0.13										0.42
Scirpus cyperinus								0.24				0.31
Solanum carolinense	12.5	0.13										
Sparganium eurycarpum		0.31		1.08		0.27				0.19		
Typha latifolia				0.17	16.7	0.15		0.15		0.06		
Xanthium strumarium							40.0	0.47				
Subtotal:		4.22		12.11		2.13		9.64		3.07		7.56
Other Taxa (n = 74):		0.36		2.55		0.49		1.96		0.67		5.51
Total:		4.58		14.66		2.62		11.60		3.74		13.072

values in bold represent species that were faithful to a particular community and RIV bold values are those species that contributed to 5% or more to that community type.

	Community											
	G		H		I		J		K		L	
Taxa	IV	RIV	IV	RIV	IV	RIV	IV	RIV	IV	RIV	IV	RIV
Ammannia coccinea												
Apios americana												
Arthraxon hispidus												
Asclepias incarnata												
Boehmeria cylindrica										0.52		
Carex stipata												
Carex tribuloides								0.11				
Commelina communis												
Commelina virginica												
Cornus amomum												
Cuscuta gronovii								0.07		0.33		0.27
Cyperus odoratus												
Elymus villosus												
Galium tinctorium						0.02		0.22		0.82		0.90
Hibiscus moscheutos								0.14		0.24		0.51
Impatiens capensis								0.08		0.40		0.19
Iris pseudacorus										0.19		
Juncus effusus							83.4	1.52				0.80
Justicia americana							15.3	0.63		0.59		
Laportea canadensis												
Leersia oryzoides						0.32		0.39		0.50	53.9	7.29
Lindernia dubia												
Ludwigia palustris					96.4	0.89				0.21		
Lysimachia nummularia												
Myriophyllum spicatum	68.0	0.29		0.15								
Najas minor	100.0	0.52										
Nelumbo lutea			99.8	0.43								
Nelumbo nucifera												
Onoclea sensibilis					0.0			0.23				0.61
Dichanthelium clandestinum												
Persicaria hydropiperoides												
Persicaria pensylvanica												
Persicaria punctata						0.13				1.24		0.63
Persicaria sagittata								0.22		0.87		1.26
Sagittaria latifolia								0.29	24.4	4.29		2.22
Schoenoplectus tabernaemontani							25.4	0.46		0.31		0.17
Scirpus cyperinus												0.47
Solanum carolinense												
Sparganium eurycarpum								0.33	53.8	7.99		2.69
Typha latifolia								0.12		0.38		0.54
Xanthium strumarium												
Subtotal:		0.81		0.58		1.36		4.81		18.88		18.55
Other Taxa (n = 74):		0.02		0.00		0.35		0.08		1.92		2.37
Total:		0.83		0.58		1.71		4.89		20.80		20.92

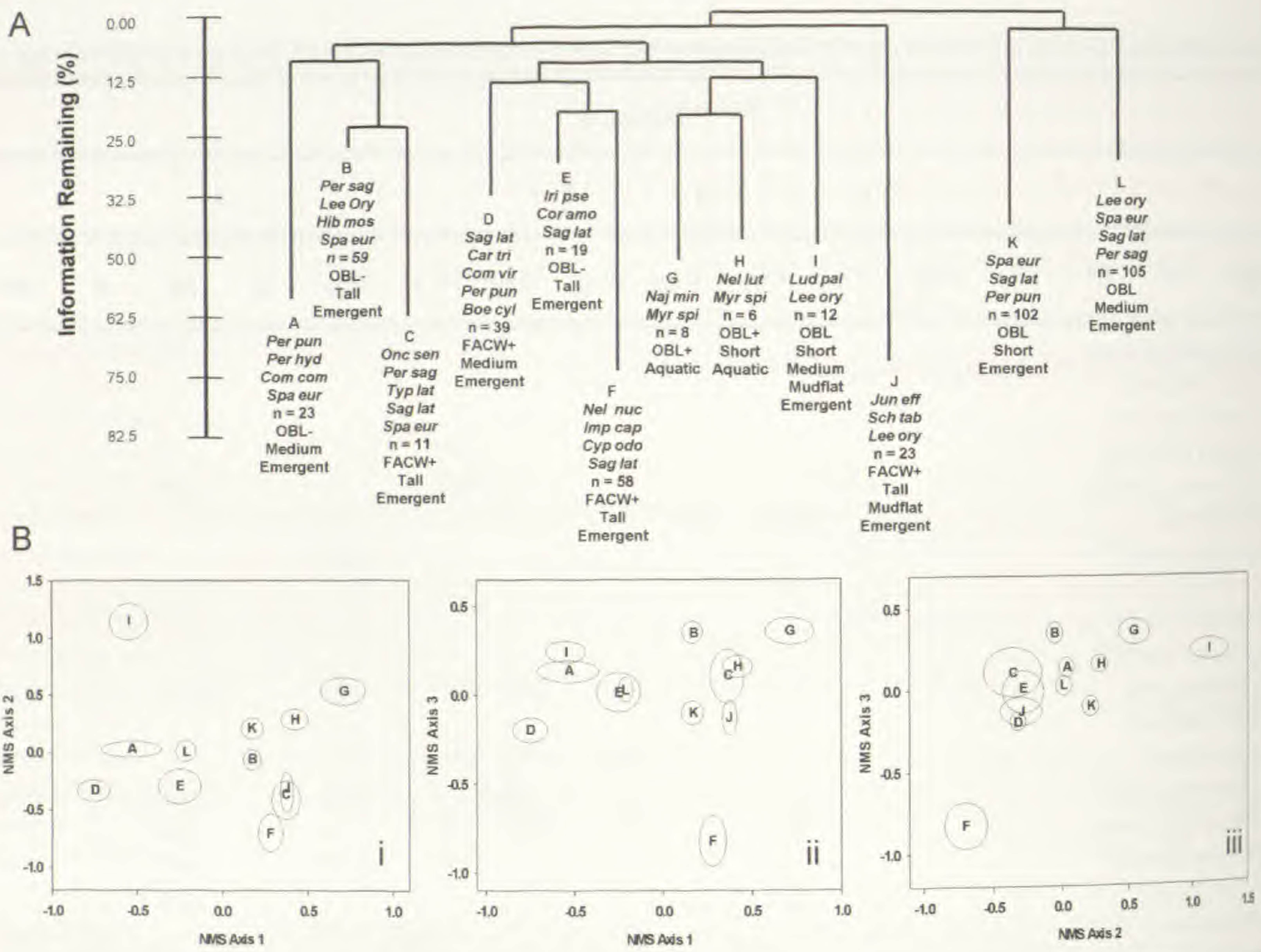

Fig. 4. A. Dendrogram of the results of hierarchical, agglomerative cluster analysis, grouping 465 1 m² quadrats into twelve community types, named for the species with the highest relative importance value and indicator value. The dendrogram is scaled by Wishart's (1969) objective function, expressed as the percentage of information remaining at each level of grouping (McCune & Grace 2002). B. Non-metric multidimensional scaling of plant community species cover and sample ordination axes scores (mean ± 1 standard error).

9) and Crab Creek (n = 1). The tall obligate- emergent community was characterized by *Hibiscus moscheutos* and *Persicaria sagittata* were the indicator and dominant species with subdominants of *Leersia oryzoides* and *Sparganium eurycarpum* (Table 4, Fig. 4, community B). This community occurred at Chandler's Run (n = 43), Ginat's Run (n = 14) and Crab Creek (n = 2). The other obligate- tall emergent community (Table 4, Fig. 4, community E) was characterized by a non-native species, *Iris pseudacorus*, and a shrub or understory tree species, *Cornus amomum* with limited contributions of *Sagittaria latifolia*. This community was distributed primarily at Teen's Run (n = 18) with one sample found at Chandler's Run.

There were three obligate emergent communities defined among embayments. *Ludwigia palustris* was the dominant and indicator species for a short or mudflat emergent community (Table 4, Fig. 4, community I) with limited contributions of *Leersia oryzoides* and minor contributions of *Persicaria punctata* was defined for Chickamauga Creek (n = 2) and Crab Creek (n = 10). The short emergent community (Table 4, Fig. 4, community K) was dominated by *Sparganium eurycarpum* and its subdominant of *Sagittaria* latifolia with limited contribution of *Persicaria punctata*. Both of the former two species were indicators. Although Teen's Run had the most number of samples (n = 61), this community was also distributed among three other embayment sites and include Chandler's Run (n = 10), Crab Creek (n = 20), Ginat's Run (n = 11). The medium obligate emergent community (Table 4, Fig. 4, community L) was dominated by the only indicator species, *Leersia oryzoides*, with limited contributions of *Sparganium eurycarpum*, *Sagittaria latifolia*, and *Persicaria sagittata*. This community was primarily at Ginat's Run (n = 59) but was found among all sites. Although Chandler's

Run and Crab Creek had nearly equal numbers of samples (20 and 21, respectively), both Chickamauga Creek and Teen's Run sample numbers were small (1 and 4, respectively).

Four Facultative Wet+ communities were comprised of an equal number of tall and medium height emergent species. Two indicator species (*Carex tribuloides* and *Commelina virginica*) shared dominance at one of the medium emergent community (Table 4, Fig. 4, community D) and was distributed among Chickamauga Creek (n = 31), Ginat's Run (n = 6) and Teen's Run (n = 2). *Onoclea sensibilis* was the dominant and indicator species at a tall facultative wet+ emergent community (Table 4, Fig. 4, community C), *Carex stipata* and *Typha latifolia* L. (broad-leaved cat-tail) were also indicators. The latter community was found at Crab Creek (n = 10) and Chickamauga Creek (n = 2). *Leersia oryzoides*, *Nelumbo nucifera*, and *Impatiens capensis* were co-dominants and indicators at a tall facultative wet+ emergent community (Table 4, Fig. 4, community F) that was distributed among four sites: Chandler's Run (n = 9), Chickamauga Creek (n = 22), Ginat's Run (n = 13) and Teen's Run (n = 14). The other tall emergent community (Table 4, Fig. 4, community J) was dominated by *Juncus effusus* with limited a contribution of *Schoenoplectus tabernaemontani* (C.C. Gmelin) Palla (soft-stem bulrush). Both species along with *Justicia americana* were indicator species but the latter species was of minor importance to the overall community and occurred primarily at Teen's Run. This community (J) was characteristic of Ginat's Run (n = 17), but was also found at Teen's Run (n = 4), Chandler's Run (n = 1) and Crab Creek (n = 1). Non-metric Multi-dimensional Scaling (see below) show that the ordination procedure separated the cluster analysis defined herbaceous plant communities (Fig. 4B i, ii, iii) among three axes.

Herbaceous Community Composition and Potential Gradients

Non-metric multi-dimensional scaling (NMS) was used to explore the relationship of herbaceous species and samples among embayment sites and cluster analysis defined groups for each site. The NMS resulted in three axes or dimensions with the number of runs for the Monte-Carlo simulations were 150. The final stress was 11.6. Ecological community data often have final stress values between 10 and 20%. Values in the lower half of this range represent reliable solutions (McCune & Grace 2002). The total proportion of variance represented by NMS was 84.6%. The first axis accounted for majority of the variation (64.0%), the second axis accounted for 13.6% and the third accounted for 7.1%. The NMS ordination axis 1 (Fig. 5i) separated Chickamauga Creek, Crab Creek and Ginat's Run from Chandler's Run and Teen's Run. The first axis was positively associated with embayment age ($\tau = 0.58$), non-native species ($\tau = 0.42$) and negatively associated with river kilometer ($\tau = -0.55$) and a weak negative association with Coefficient of Conservatism (CC) ($\tau = -0.22$), richness ($\tau = -0.09$) and diversity ($\tau = -0.11$). The MRPP for the testing of differences in herbaceous species cover and sample data were weakly defined among age of embayment sites ($T = -60.18$, $\delta = 0.47$, $A = 0.21$, $P < 0.01$). The second axis separated Chandler's Run and Teen's Run from the other sites (Fig. 5ii). This axis was positively associated with Wetland Indicator Status Values ($\tau = 0.45$). Richness ($\tau = -0.41$) and diversity ($\tau = -0.36$) had a negative association with the second axis. The third axis separated all sites except for Chickamauga Creek and Crab Creek (Fig. 5iii) and was positively associated with embayment site ($\tau = 0.64$), embayment size ($\tau = 0.27$) and river kilometer ($\tau = 0.15$). Species cover ($\tau = -0.18$), richness ($\tau = 0.16$), diversity ($\tau = -0.12$), CC ($\tau = -0.12$) and Wetland Indicator Status Value ($\tau = -0.09$) were negatively associated with this axis. The MRPP for the testing of differences in herbaceous species cover and sample data were moderately defined according to river kilometer (site) among embayment sites ($T = -79.83$, $\delta =$ of 0.41, $A = 0.18$, $P < 0.01$).

DISCUSSION

Floodplains have been traditionally 'hotspots' of community and species diversity (Gopal & Junk 2000) due to the characteristics of the flood pulse processes (Junk & Wantzen 2004; Junk 1997; Middleton 2002). In addition, local species richness and diversity in small wetland areas are typically high (Flinn et al. 2008) because of the diversity of habitats along hydrological gradients that result in defined niches (Silvertown et al. 1999; Silvertown et al. 2001). There are limitations of the current study and include the inferred environmental gradients from floristic quality index values (Wetland Indicator Status and Coefficient of Conservatism), limited distribution of study sites along the Ohio River, and pseudoreplication (Hurlbert

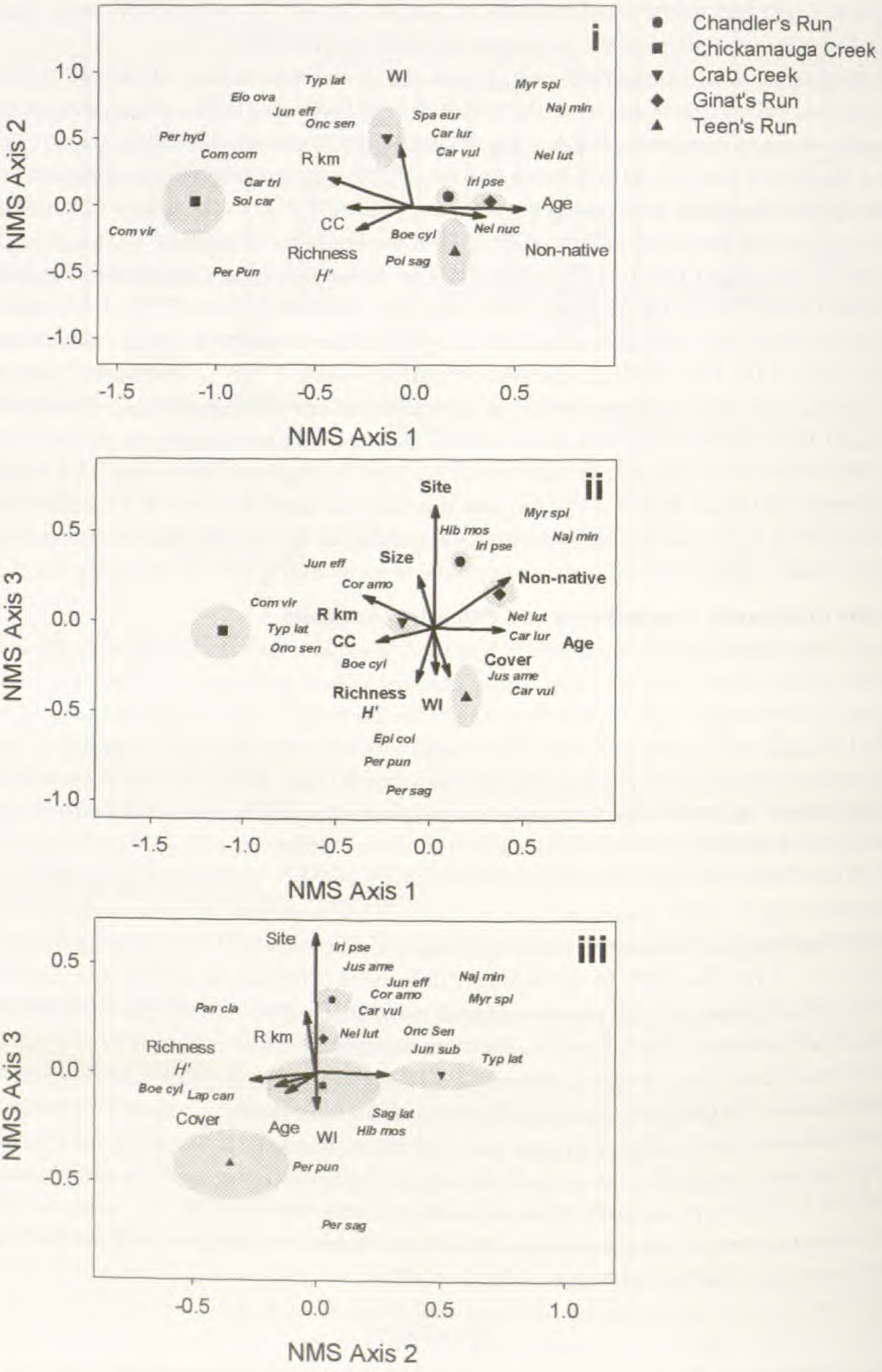

FIG. 5. Samples and herbaceous species non-metric multi-dimensional scaling (NMS) ordination bi-plots of plant species cover data among embayment sites. NMS ordination of plant species cover values and environmental data from 465 1 m^2 quadrats composition surveyed from five embayment sites. Joint bi-plots showing relationships between ordination axes and individual plant species, river location (R km), age, richness, diversity (*H'*), Coefficient of Conservatism values (CC), wetland indicator probability values (WI), total cover values, non-native plant species cover, and site. Plant species cover values associated with each axis are also given and consists of the first three letters of the genus and specific epithet. The angles and lengths of the radiating lines indicate the direction and strength of the association, based on Kendall's correlations (Zar 2010) between axis scores and values of plant species cover and environmental variables. The bi-plots only shows correlations of $|r| > 0.15$.

1984). However, the authors feel that this study provides baseline data, plant community classification, potential gradients, and species information for future work along the Ohio River and other major navigable rivers where embayments may have been formed. We document species composition, structure, diversity, plant communities and potential gradients of embayment wetlands that occur along the mid- to mid-upper Ohio River floodplain.

There were 257 species of vascular plants recorded from approximately 27 ha of embayment habitat. Our results are in accord with other wetland studies of the region. For example, Stark (1993) reported 335 species from Green Bottom Wildlife Management Area while West and Evans (1982) recorded 252 vascular plant species along the Kanawha River. Both of the latter studies encompassed a combined study area of approximately 400 ha. There were 360 species recorded in a classical study of the floodplain vegetation and environment along the Raritan River, NJ, but encompassed the entire floodplain from terrace to terrace (Wistendahl 1958). In another example, a total of 629 vascular plants were recorded along a 660 mile stretch of two rivers in a study of the plant communities, vegetation and environmental characteristics of the Wabash and Tippecanoe Rivers by Lindsey et al. (1961).

Sixty-four of the 257 species observed (34.6%) occurred at all embayment sites. However, these species are common and widely distributed elements of the region. The remaining 192 species have a more limited distribution with 36 (5.3%) at four sites, and 23 (9.0%) at three sites. Of those species most restricted in distribution, forty-five taxa (17.4%) occurred at two sites, and the largest number of taxa, 90 (34.6%), were limited to a single site.

Embayment sites capture approximately 25% of the species that are common elements of the floodplain. However, more than half the number of species encountered across the sample area was restricted to one or two sites. This suggests that these wetlands have common elements at large broad scales with distinct elements at small scales.

The woody species that defined the embayment bottomland hardwood forests were common elements of the Ohio River riparian zone. The *Acer saccharinum*, *Fraxinus pennsylvanicum*, *Platanus occidentalis*, and *Salix nigra* community dominated the forests and our results (Table 1) are consistent with other riparian studies along the Ohio River floodplain and other large rivers (Clagg & Mills 1978; Evans 1980, 1977a, 1977b; Furry & Evans 1979; Koryak 1978; Liu 1991; Stark 1993). The forests encountered in this study would be considered an *Acer saccharinum* forest alliance as defined by The Nature conservancy (Weakley et al. 1996). Ginat's and Teen's Run embayment sites had the greatest tree species diversity among all sites and is probably due to the degree of disturbance or lack of it. Ginat's Run forest is secluded from surrounding agriculture fields and development and has had minimal disturbance while Teen's Run site has had significant amount of disturbance in the past with numerous homesteads and agriculture. In addition, Ginat's Run's forest were more even-aged than the remaining embayment sites that were characterized by high recruitment of *Acer saccharinum* as indicated by the density of trees in the smallest size class (Ely 1993).

Although *Acer saccharinum* was the dominant tree species, it had a limited distribution among the shrub and sapling layer (Table 2). *Alnus serrulata* was the dominant shrub at Ginat's Run with very limited contributions of other species including *Acer saccharinum*. *Cornus amomum* and *Salix nigra* were co-dominants with *Acer saccharinum* at Teen's Run. *Acer saccharinum* along with *Lindera benzoin* were sub-dominants to *Fraxinus pennsylvanicum* at Crab Creek. The shrub alliances (Weakley et al. 1996) among embayments were more diverse than the tree layer. Chickamauga Creek's shrub community would be considered a *Cephalanthus occidentalis* shrub alliance while Ginat's Run would be an *Alnus serrulata* alliance. Chandler's Run shrub layer would be mix of *Alnus serrulata* and *Salix nigra* and the shrub community at Crab Creek would be considered a *Lindera benzoin* mixed alliance with *Betula nigra* and *Asimina triloba* (L.) Dunal (pawpaw). Finally, Teen's Run alliance is characterized by *Cornus amomum*, a Midwestern element.

At the local scale (embayment site) herbaceous species composition, richness and diversity show that there were differences among sites (Fig. 3i, ii). In addition, sites with significantly higher species richness and diversity tended to have the lowest wetland indicator and coefficient of conservatism values (Fig. 3i, ii, iv, v). Two embayment sites have non-native species cover values approaching 20% while the remaining sites are below 10% (Fig. 3vi). Chickamauga Creek and Teen's Run embayment sites would be considered the most disturbed of the five sites. Chickamauga Creek site is surrounded by the city of Gallipolis, Ohio, and adds to the level of disturbance along the edge of that site. Teen's Run while in a remote location consists of former farmsteads and agricultural fields. There were two non-native species that were important components of several communities at Chickamauga Creek and Teen's Run, *Nelumbo nucifera* and *Iris pseudacorus* L. (yellow flag), respectively, both species were indicators and important component of the plant communities (Tables 3 and 4; Fig. 4) *Nelumbo nucifera* was previously reported by M. L. Roberts in 1973 (Cusick & Silberhorn 1977). Another non-native species, *Amaranthus cruentus* L. (purple amaranth), was also recorded for the second time from this site; however, this taxon is cultivated as an ornamental and often escapes cultivation. Lopez and Fennessy (2002) found that the Coefficient of Conservatism values tend to be low in Ohio wetlands that are surrounded by agriculture fields and urban centers. This is consistent with Cohen et al. (2004) findings of the effect of landscape development of intensity on Coefficient of Conservatism values in depressional marshes of Florida. Floodplains and riparian zones are generally vulnerable to non-native and invasive species under normal conditions due to the dynamic nature of riparian systems but more so under altered hydrological conditions (Nilsson & Berggren 2000).

The NMS ordination of species and samples were associated with age and river kilometer (Fig. 4i; axis 1), wet gradient or water depth (Fig. 4i; axis 2, as indicated by wetland indicator status values and distance of sample plots from the edge of the embayment to open water), size and site (Fig. 4ii, iii; axis 3). Non-native species cover, total cover, Coefficient of Conservatism, Richness, and Diversity were associated moderately to the ordination scores. Furthermore, MRPP was able to detect differences in species and species cover values among embayment sites, age, and river kilometer location. These results indicate that embayment location, size, and age are factors that determine the distribution and abundance of plant species.

Of the herbaceous plant communities we defined, there were four groups that were distinct and had limited integration with the other herbaceous communities. These include two aquatic and two emergent communities. Two communities of lotus (*Nelumbo nucifera* and *N. lutea*) are considered distinct and unique for this region of the Ohio River (Table 4 and Fig. 4). The *Nelumbo lutea* community was an important component of the emergent-submerged aquatic community at Ginat's Run and was unexpected for the unglaciated region of the state (Alison Cusick, pers. comm.; Cusick & Silberhorn 1977). The tall emergent community at Chickamauga Creek is the only known community along the Ohio River that has a dominant and indicator species of *Nelumbo nucifera*, an introduced taxon. The remaining eight defined communities are composed of common elements of the region and are not unexpected. Communities are typically composed of species that are distributed along an integrated series of aquatic, wetland and upland habitats and are consistent with riparian forests of the Allegheny Plateau, Pennsylvania (Williams et al. 1999).

The purpose of this study was to classify and describe plant communities of selected embayment sites along the mid to mid-upper Ohio River floodplain. We classified five *Acer saccharinum* bottomland hardwood forest communities, five sapling and shrub and twelve herbaceous plant communities. Herbaceous plant species and communities were further analyzed through the use of indirect ordination procedures and non-parametric tests in order to describe potential environmental gradients. We also have provided baseline information on embayment plant communities along this stretch of the Ohio River that allows for future comparative studies. Future embayment work needed includes surveys of the flora, fauna (all types), classification, characterization of nutrient cycling, productivity analyses, soil classification, successional relationships and hydrological surveys.

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BOOK REVIEW

Gary A. Laursen and Rodney D. Seppelt. 2009. **Common Interior Alaska Cryptogams, Fungi, Lichenicolous Fungi, Lichenized Fungi, Slime Molds, Mosses, & Liverworts.** (ISBN 978-1-60223-058-3, pbk.). University of Alaska Press, PO Box 756240, Fairbanks, Alaska 99775, U.S.A. (**Orders:** www.uaf.edu/uapress or Chicago Distribution Center, 11030 South Langley Avenue, Chicago, Illinois 60628, U.S.A.; 1-800-621-2736, 1-800-621-8476 fax). $26.95, 218 pp., 338 color figures, 113 b&w figures, 6" × 9".

This book has a wealth of information that includes much more than the typical field guide at a bargain-basement price. The front cover has a durable glossy lamination that will protect it from rain, liquid spills, and wear and tear in the field. The spine is Smythe sewn and wrapped with a 260-gsm C2S stock to ensure against the pages falling apart. The smaller size will facilitate carrying this book in hand while picture-keying field collections.

Topical headings include a brief Introduction and Interior Landscapes along with striking color vistas and landscape images. A history of the Denali National Park and Preserve and Mount McKinley (North America's highest mountain at 20,320 feet) provides the setting for this vast area. Additional sections such as Fungal Ecology, Mushroom Architecture (with excellent line drawings representing mushroom morphological terminology), Where to Look for Fungi, Forest Fungi, Treeline Fungi, Tundra Fungi, Riparian Fungi, and Disturbed Area and other Specialized Habitat Fungi also have lists of cryptogams found in each of these ecological habitats. These species-habitat associations represent valuable additional ecological information that increases the chances of collecting certain cryptogams. Under the broad rubric of "cryptogams" the following groups are included with species descriptions and illustrations and the number of taxa given in parentheses: gilled fungi (80); gasteromycetes (5); rust, jelly, cup, earth tongue (12); lichenicolous fungi (22); lichens (18); plasmodial slime molds (11); mosses, liverworts, and hornworts (43). The following information is given for each species listed: Family, Genus and Species, Common Name, Striking Field Characters, Macro and Micro Description, Habitat and Role, Edibility, Taste, and Odor.

This book lacks keys to the general groups or to orders, families, and genera, therefore as a picture guide the color images should be of high resolution, true color rendition of high quality, and appropriate magnification and depth of field to show external morphological detail. Unfortunately many color images are undersized—approximately 2 5/16" × 1 1/2"—to take less space on the page, the colors are washed out and lack sufficient magnification to show characteristics close-up, as is the case for many of the lignicolous fungi, lichens, and bryophytes. In contrast, the close-up color image of the myxomycete *Perichaena minor* showing the stalked sporangia with dark peridial warts is one of the best photographs of this species ever published. The photo credits are attributed to six people but not associated with specific color images as in most publications. The line drawings that illustrate some of the moss species show the microscopic cell patterns of the leafy gametophytes and structures of the sporophytes.

Another field guide titled *Alaska's Mushrooms, A Practical Guide* by Harriette Parker includes 34 species of edible and poisonous species illustrated with color images. However, this pocket book is only 94 pages and was intended more for the beginning mushroomer, and while there is some overlap, some of the species illustrated are not present in *Common Interior Alaska Cryptogams*, and the latter book should appeal more to the professional mycologist and experienced field collector of cryptogams.

The extensive glossary of terms (pages 181–194) will aid the collector in understanding the species descriptions. The references cited on pages 199 to 204 include broad coverage of all of the fungal groups, but several monographs on the myxomycetes, mosses, and liverworts would have been valuable additions. The Appendix has a valuable section titled Mycological Reagents: Makeup and Use that mainly targets macrofungi. The Index to Species is arranged alphabetically by families, genera, species, and common names.

Alaska represents a relatively unexplored vast area, and this book helps to fill a void for groups of organisms where little is known. The content of this book will be of utmost interest to outdoor professionals in the forest service, summer visitors, and nature enthusiasts who wish to learn more about the wonders beneath their feet in the land of the midnight sun. The authors are truly trailblazers who have increased our appreciation for the role of cryptogams in one of the last frontiers in North America.—*Harold W. Keller, Research Associate, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas 76102-4025, U.S.A.*

CHECKLIST OF THE VASCULAR PLANTS OF ALLEGHENY COUNTY, PENNSYLVANIA

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ABSTRACT

Botanists have documented the flora of Allegheny County since the early 1800s. However, only an incomplete checklist of the county's vascular flora has recently been available, last compiled in the 1950s. A search of herbaria has resulted in a list of 1576 taxa of native and naturalized plants comprising 628 genera and 142 families. The five families with the largest number of species are Asteraceae, Poaceae, Rosaceae, Cyperaceae and Fabaceae. *Carex, Viola, Crataegus, Symphyotrichum* and *Rubus* are the five largest genera. This checklist recognizes 10 species of Lycophytes, 44 species of Polypodiophytes, 5 species of Equisetophytes, 12 species of Gymnosperms and 1462 species of Angiosperms. Approximately 400 non-native species have been introduced, mainly from Europe and Eurasia. By The Nature Conservancy's system of conservation status designations, 103 species have global or state ranking.

RESUMEN

Los botánicos han documentado la flora del condado de Allegheny desde principio de los 1800s. Sin embargo, sólo ha estado disponible una lista incompleta de la flora vascular del condado, compilada por última vez en los 1950s. Una búsqueda en herbarios ha dado como resultado una lista de 1576 taxa de plantas nativas y naturalizadas que se incluyen en 628 géneros y 142 familias. Las cinco familias con mayor número de especies son Asteraceae, Poaceae, Rosaceae, Cyperaceae y Fabaceae. *Carex, Viola, Crataegus, Symphyotrichum* y *Rubus* son los cinco mayores géneros. En esta lista se reconocen 10 especies de Licófitos, 44 especies de Polypodiófitos, 5 especies de Equisetófitos, 12 especies de Gimnospermas y 1462 especies de Angiospermas. Se han introducido aproximadamente 400 especies exóticas, principalmente de Europa y Eurasia. Según las designaciones de status del sistema de conservación del Nature Conservancy, 103 especies tienen nivel global o estatal.

INTRODUCTION

Even though Pennsylvania lacks checklists for most of its counties, the vascular flora known thus far is quite diverse. Rhoads and Klein (1993) reported 3318 taxa of vascular plants for the state, including 2076 native and 1242 introduced. Approximately 27 of Pennsylvania's 67 counties have floras completed, but some are unpublished theses and surveys and therefore unavailable to the public. The exact number of genera and species in the flora of Allegheny County was heretofore poorly known because the most recent checklist had been compiled over 50 years ago. This paper is an updated checklist providing the baseline information needed to monitor environmental changes and guide conservation decisions.

Site Description

Allegheny County, Pennsylvania, is located in the southwestern part of the state (Fig. 1). It is bordered by Butler and Armstrong Counties to the north, Westmoreland County to the east, Washington and Beaver Counties to the west.

Total annual precipitation in Allegheny County is approximately 36 to 40 inches. Average seasonal snowfall is 30 inches annually in the southern valley areas to nearly 50 inches at the higher northern elevations. Snow cover of 1 inch or more occurs about 20 days each year in the south and about 45 to 50 days in the north.

The average date of the last 32 degree temperature in the spring is usually around April 29th and the first frost of the season approximately October 15th. The length of the growing season, from the last killing frost in spring to the first killing frost in autumn, is about 170 days (USDA 1981).

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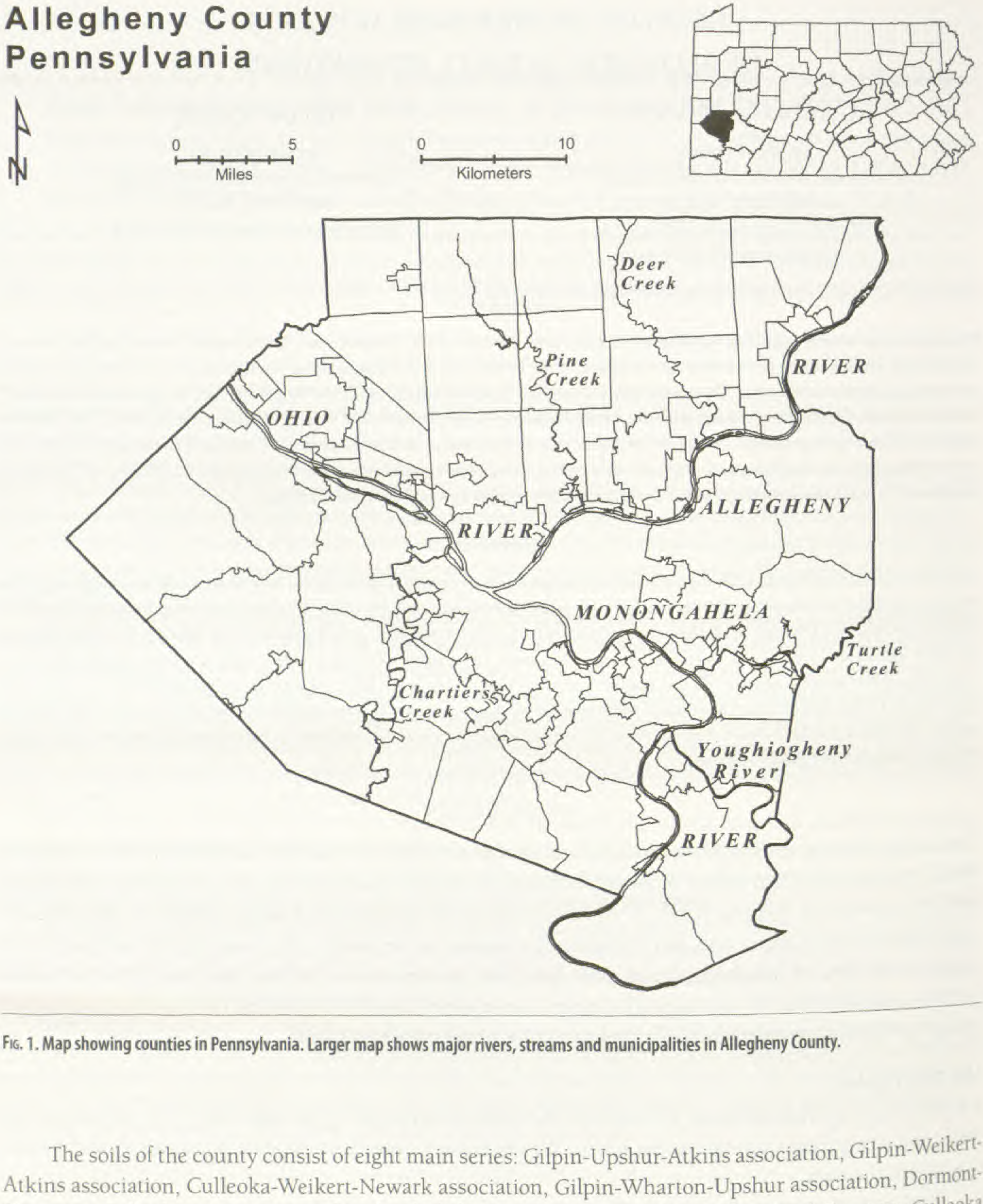
Allegheny County
Pennsylvania
N
0 5
Miles
0 10
Kilometers
Deer Creek
Pine Creek
RIVER
OHIO
ALLEGHENY
RIVER
MONONGAHELA
Turtle Creek
Chartiers Creek
Youghiogheny River
RIVER

Fig. 1. Map showing counties in Pennsylvania. Larger map shows major rivers, streams and municipalities in Allegheny County.

The soils of the county consist of eight main series: Gilpin-Upshur-Atkins association, Gilpin-Weikert-Atkins association, Culleoka-Weikert-Newark association, Gilpin-Wharton-Upshur association, Dormont-Guernsey-Culleoka association, Urban land-Philo-Rainsboro association, Urban land-Dormont-Culleoka association, and Strip mines-Guernsey-Dormont association. These soils associations can be grouped into two general kinds of landscapes: areas that are unaltered and areas altered by urban development and strip mines (USDA 1981).

The first five associations listed above are from areas that are unaltered by urban development and strip mines and make up about 74 percent of the county.

Gilpin-Upshur-Atkins association is located mainly on steep and very steep sides of valleys but also includes narrow, nearly level flood plains. These soils are moderately-deep to deep and well-drained. The soils are underlain by red and gray shale on uplands and deep, poorly drained soils on flood plains. This soil association makes up about 15 percent of the county. The area is mostly wooded; due to flooding and steepness of the terrain, other land uses are limited.

Gilpin-Weikert-Atkins association is located mainly on steep and very steep sided valleys but also includes narrow, nearly level flood plains. These soils are shallow to moderately deep, and well-drained. They are underlain by gray shale on uplands and deep, poorly drained soils on flood plains. This soil association makes up about 5 percent of the county. The area is mostly wooded; due to flooding and steepness of the terrain, other land uses are limited.

Culleoka-Weikert-Newark association is also located mainly on steep and very steep sided valleys and includes narrow, nearly level flood plains. These soils are shallow to moderately deep, and well-drained. They are underlain by shale and limestone on uplands and deep, poorly drained soils on flood plains. This soil association makes up about 4 percent of the county. The area is mostly wooded; due to flooding and the steepness of the terrain, other land uses are limited.

Gilpin-Wharton-Upshur association is on undulating to hilly uplands and is highly dissected by small streams and drainage ways. These soils are moderately deep to deep and moderately to well-drained. These soils are underlain by red and gray shale on uplands. This soil association makes up about 32 percent of the county. Much of this area has been cleared. Some of the cleared areas are under continued suburban development while others are used for recreation, are farmed or remain idle. Artificial drainage is needed in many areas while other areas are susceptible to landslides.

Dormont-Guernsey-Culleoka association is on undulating to hilly uplands and is highly dissected by small streams and drainage ways. These soils are moderately deep to deep and moderately to well-drained. They are underlain by shale and limestone on uplands. This soil association makes up about 18 percent of the county. Much of this area is under continuous suburban development while other cleared areas are used for recreation, contain scattered farms or remain idle.

The Urban land-Philo-Rainsboro association, Urban land-Dormont-Culleoka association, and Strip mines-Guernsey-Dormont association make up about 20 percent of the county and contain areas that are altered by urban development and strip mines.

Urban land-Philo-Rainsboro association is mainly on nearly level bottom land adjacent to major streams. These soils are deep and moderately well-drained on flood plains and terraces. This soil association makes up about 6 percent of the county. Most of this area is used for residential, commercial, and major industrial developments and for major highway and railroad routes. In general some areas are prone to flooding.

Urban land-Dormont-Culleoka association is in the southern half of the county. It is on nearly level to hilly uplands that are dissected by small streams and drainage ways. The soil is moderately deep to deep and moderately to well-drained. The urban land is underlain by shale while the uplands are underlain by limestone. This soil association makes up about 9 percent of the county. This association is used mainly for urban development. Most land is limited by a seasonal high water table.

Strip mines-Guernsey-Dormont association is in the southern half of the county. It consists of rolling to very steep areas that have been strip mined. The soil is deep and moderately well-drained. The strip mines are underlain by shale and limestone on uplands. This soil association makes up about 5 percent of the county. Much of the land remains idle and vegetation is sparse (USDA 1981).

Allegheny County consists of a hilly region that is situated in the Allegheny Plateau physiographic region. The Allegheny Plateau is mainly covered by hardwood forest. The county is bounded partially by the Monongahela and Youghiogheny Rivers to the southeast and partially by the Allegheny River to the northeast. Elevations range from a high of 1,200 feet to a low of 82 feet above sea level.

Allegheny County is known for the three major rivers that flow through it: the Allegheny and the Monongahela converge at Pittsburgh to form the Ohio River. An additional river, the Youghiogheny, meets the Monongahela at McKeesport, 10 miles south of Pittsburgh. Allegheny County contains seven major watersheds, located in the subbasins of the lower Allegheny River, the Monongahela River and the Ohio River.

The Lower Allegheny River watershed drains a total area of 324 square miles. Its major waterways include the lowest portion of the Allegheny River and Deer Creek, which originates north of Allegheny County.

The watersheds of the Monongahela subbasin in Allegheny County include the Lower Youghiogheny River, the Middle Monongahela River and Turtle Creek. The Lower Youghiogheny River watershed has a total drainage area of 478 square miles and its major waterway in Allegheny County is the lower Youghiogheny River, which enters the county in the southeast. The Middle Monongahela River watershed has a total drainage area of 509 square miles and its major waterway in Allegheny County includes the lower portion of the Monongahela River. Turtle Creek watershed has a total drainage area of 202 square miles and its major stream is Turtle Creek. This watershed drainage area includes forest, farmland, industry, abandoned mined lands, as well as urban and suburban residential communities.

The Ohio subbasin contains the following watersheds: Chartiers Creek, Raccoon Creek and Upper Ohio River. Chartiers Creek drains a total of 296 square miles and enters Allegheny County in the southwest. Raccoon Creek drains 327 square miles and creates a portion of the western boundary of Allegheny County. Forty miles of the main stem of Raccoon Creek and 30 to 40 miles of tributaries are degraded by mine drainage. The Upper Ohio River watershed has a total drainage area of 209 miles; Sewickley Creek and the upper portion of the Ohio River are its major water ways.

Watershed conditions need to be evaluated to detect if biodiversity is increasing or decreasing. Comparison studies between years and sites will be extremely important in mining areas because they will reflect the interactions of many of the other environmental indicators, and these comparisons provide measurable effects for management decisions (Pennsylvania DEP Watershed Notebook, 2006).

History

Allegheny County was the first county in Pennsylvania to be given a Native American name. During the colonial era various native groups, such as the Iroquois, Lenape, Shawnee, and Mingo, settled in the area. Very little however is known about the native inhabitants of the region prior to European contact. The first known European settlers to enter the area were the French in 1749. The French claimed the Ohio Valley and all of Western Pennsylvania for Louis XV of France. Both the French and the British desired control over the rivers because most of the towns were developed along rivers. In 1754, George Washington forged an expedition into the region which ended in defeat by the French and Indians at Fort Necessity. In 1758 the British won the French and Indian War and settlers came back into the region. In the 1770s both Pennsylvania and Virginia claimed the region that is now Allegheny County. Pennsylvania administered most of the region as part of Westmoreland County. Virginia considered everything south of the Ohio River and east of the Allegheny River to be part of its Yohogania County and governed it from Fort Dunmore. The overlapping boundaries, multiple governments, and confused deed claims soon proved unworkable. The claims were settled in 1780 when the Mason-and-Dixon Line was extended to the original limit of Penn's land grant, giving Virginia frontage on the Ohio River, but ceding the land north of the Mason-and-Dixon Line to Pennsylvania.

Allegheny County was created in September 24, 1788 from portions of Washington and Westmoreland Counties. The county's current borders were settled by the 1800s.

In the late 1700s farming played a critical role in the growth of the area. During this period a surplus of grain occurred due to transportation difficulties and the farmers began to distill the grain into whiskey. The production of whiskey significantly helped the economy of the farmers until the 1790s when a whiskey excise tax was imposed. This started the Whiskey Rebellion when the farmers who depended on whiskey income refused to pay. After a series of demonstrations by farmers, President George Washington arrived with troops to stop the rebellion.

The county's strategic location and wealth of natural resources spurred its commercial and industrial growth in the 19th century. The blast furnace, erected by George Anschutz about 1792, was the forerunner of the iron and steel industry that for more than a century was the county's economic mainstay. Pittsburgh, the county seat, would later be labeled the Steel Capital of the World. The Pennsylvania Canal and the Portage Railroad, both completed in 1834, opened vital markets for trade and shipping. As the 19th century progressed, Pittsburgh became one of the nation's greatest industrial cities and was a leading producer of glass, iron and textiles. During the American Civil War the county became a supplier to the Union and the iron industry and its shipyards gained wealth. After the American Civil War, great numbers of European immigrants moved into the area. Transportation improvements facilitated growth, and by 1900 nine railroad lines entered Pittsburgh. The Army Corps of Engineers constructed an extensive series of locks and dams during this time which improved shipping. World War II and the industrial demand it created temporarily boosted Pittsburgh's economy.

By the late 1970s, the steel industry had virtually disappeared. Over 100,000 steel and steel-related jobs were eliminated between 1978 and 1983. By the mid-1980s many of the region's manufacturing plants had gone out of business or left the area. Since then the county has successfully diversified its economy based on services, especially medical, financial, corporate, and educational, rather than steel. In 2008, Pittsburgh has been ranked in the top ten among U.S. cities hosting headquarters of Fortune 500 corporations. These include major corporations such as U.S. Steel Corp., H.J. Heinz, PNC Financial Services Group, and PPG industries (Alan Enterprise 2007).

The county is divided into 130 municipalities with the majority of the population residing in the urban and suburban areas. The first census taken in 1790 documented that Allegheny County had a population of nearly 10,309. As of 2000, the population was 1,281,666.

According to the U.S. Census Bureau, the county has a total area of 1,929 km^2 (745 sq mi); 1,891 km^2 (730 sq mi) of it is land, and 38 km^2 (15 sq mi) is water (U.S. Census Bureau 2009).

Major Collectors

Collecting in Allegheny County for the Carnegie Museum Herbarium began in the early 1800s and has continued to the present. Most of the collectors have been members of the Botanical Society of Western Pennsylvania and the staff of the Section of Botany at Carnegie Museum.

Botanists who have made significant contributions to the knowledge of the Allegheny County are W.A. Zanol, W.E. Buker, O.E. Jennings, J. Bright, and B.L. Isaac and J.A. Isaac.

METHODS

This checklist was compiled by searching the herbaria of the Carnegie Museum of Natural History (CM). Herbarium collection information was obtained from the Morris Arboretum (MOAR). Other herbaria that were examined for specimens include the Academy of Natural Sciences of Philadelphia. In addition, fieldwork was conducted targeting underrepresented areas of the county. Most of the collections were made during the late 1940s and early 1950s but several specimens date back as far as 1873 and 1875. The majority of the specimens are deposited at the Carnegie Museum of Natural History (CM). Rhoads and Block (2000) was the primary source for plant identification. For generic and species names, we have generally followed the Synthesis of North American Flora (Kartesz 1999). Authorities are abbreviated for the majority of taxa according to Brummitt and Powell (1992).

RESULTS AND DISCUSSION

This list includes the names of all native and naturalized species known to occur in Allegheny County. It includes a total of 142 families, 628 genera, and 1533 species. The five families with the largest number of species are Asteraceae, Poaceae, Rosaceae, Cyperaceae and Fabaceae. *Carex, Viola, Crataegus, Symphyotrichum* and *Rubus* are the five largest genera. This checklist recognizes 10 species of Lycophytes, 44 species of Polypodiophytes, 5 species of Equisetophytes, 12 species of Gymnosperms and 1462 species of Angiosperms. There are approximately 400 non-native species that have been introduced mainly from Europe and Eurasia. 103 species have global or state conservation status ranking as defined by The Nature Conservancy.

Of the 103 plants that have global or state ranking, one has G2 status, and four have G3 status. The remaining 98 plants are either a G4 or G5 status, indicating, respectively, an apparently secure or secure condition globally.

Potamogeton tennesseensis (Tennessee pondweed) has a status of G2 or an imperiled status. This species contains floating leaves 2 to 4 cm long and 5 to13 mm wide. Submersed linear leaves are 1 to 3 veined with prominent lacunar bands, whereas the floating leaves have 9 to 23 veins. The stipules are fused to the leaf bases for ¼ or less of their length, or are free. The achenes are orbicular with a winged keel. The small size of *P. tennesseensis*, in combination with the acute floating leaves, renders the species reasonably distinctive; the species can however be confused with an immature specimen of *Potamogeton epihydrus*.

With a status of G3 or vulnerable status, is *Scutellaria saxatilis* (rock skullcap). These plants are slender and decumbent with glabrous or eglandular stems. The leaves are glabrous, petioled, ovate-shaped and rounded at the base. The margins have fewer than 10 rounded teeth on each side. This species has a distinctive prominent protuberance on the upper corolla. The flowers are in terminal few-flowered racemes and have bracts underneath the calyx. This species can be confused with *Scutellaria ovata*, but this species has much longer leaves and is not decumbent.

Trifolium reflexum (buffalo clover) has a status of G3G4 or vulnerable to apparently secure status. These plants are 1 to 5 cm tall and are not stoloniferous. They have globose heads that are 2.5 to 4.5 cm in diameter and each flower has a pedicel at least 2 mm long. The corolla has a red or white standard and white wings and keel. *T. reflexum* has calyx teeth that are twice or more than twice as long as their calyx tube. This species can be confused with *Trifolium hybridum*, *T. pratense*, or *T. stoloniferum* (Vincent 1991); however, *T. reflexum* is distinctive in having long calyx teeth, long pedicels, and by lacking stolons.

With a ranking of G3 or vulnerable status, *Crataegus pennsylvanica* (Pennsylvania hawthorn) is a tree of up to 10 meters with slender thorns that become stout with age. Their leaves are broadly ovate and sharply toothed with 4 to 6 pairs of shallow lateral lobes. When young the leaves are densely hairy on the underside, but the hairs become more infrequent with age. The upper surface of the leaves is scabrous. The flowers are stalked with bases of the stalks densely hairy, the sepals have glandular teeth, and the stamens are about 10 in number. Their anthers are ivory-colored. The fruits are about 12 mm in diameter.

Delphinium exaltatum also has a global ranking of G3 or vulnerable status. *Delphinium exaltatum* contains alternate leaves palmately divided into 3 to 5 parted segments, 15 cm long, silvery-green abaxially and pubescent above and below. The basal lobes of some of the larger leaves are divided again and make the blade appear 5-lobed. The flowers are in terminal racemes. The 4 purplish-blue petals are dimorphic with the upper two petals expanded at the base and forming a spur. The lateral petals are reflexed in the apical half with long white hairs. The stamens are approximately 30 in number with yellow pollen. The 5 sepals are irregular. The species can be confused with *Delphinium tricorne*; however *D. tricorne* is a smaller plant and flowers much earlier than *D. exaltatum*, in May to early June. By July, when *D. exaltatum* is beginning to flower, *D. tricorne* already has set fruit. Most of the collections are from rich shaded woods and on rocky limestone bluffs. This species is quite conspicuous and may be subject to casual picking or may be dug for gardens.

There are 8 taxa in the Allegheny County flora that are listed by the Pennsylvania Department of Agriculture (2007) as noxious weeds. It is therefore illegal to propagate, sell or transport the following taxa in the Commonwealth: *Cannabis sativa* (marijuana), *Cirsium arvense* (Canadian thistle), *Cirsium vulgare* (bull or spear thistle), *Datura stramonium* (jimsonweed), *Lythrum salicaria* (purple loosestrife), *Pueraria montana* var. *lobata* (kudzu), *Rosa multiflora* (multiflora rosa), and *Sorghum halepense* (Johnsongrass). Other species considered serious invasives in Pennsylvania's native ecosystems are: *Aegopodium podagraria* (bishop's goutweed), *Ailanthus altissima* (tree-of heaven), *Akebia quinata* (chocolate-vine), *Alliaria petiolata* (garlic mustard), *Ampelopsis brevipedunculata* (amur peppervine), *Berberis thunbergii* (Japanese barberry), *Berberis vulgaris* (European barberry), *Bromus tectorum* (cheat grass), *Celastrus orbiculatus* (oriental bittersweet), *Elaeagnus umbellata* (autumn olive), *Euonymus alatus* (winged euonymus), *Hesperis matronalis* (dame's rocket), *Ligustrum vulgare* (common privet), *Lonicera japonica* (Japanese honeysuckle), *Lonicera maackii* (Amur honeysuckle), *Lonicera morrowii* (Morrow's honeysuckle), *Lonicera tartarica* (Tartarian honeysuckle), *Miscanthus sinensis* (Chinese silver grass), *Ornithogalum nutans* (drooping star-of-Bethlehem), *Ornithogalum umbellatum* (star-of-Bethlehem), *Pastinaca sativa* (wild parsnip), *Paulownia tomentosa* (princesstree), *Phalaris arundinacea* (reed canary grass), *Phragmites australis* (common reed), *Polygonum cuspidatum* (Japanese knotweed), *Rhamnus cathartica* (European buckthorn), *Rubus phoenicolasius* (wine raspberry), *Ulmus pumila* (Siberian elm) and *Viburnum opulus* var. *opulus* (highbush-cranberry) (DCNR 2004).

While this checklist may be incomplete, it is the most comprehensive list of Allegheny County species presently available.

ANNOTATED CHECKLIST OF THE SPECIES OF ALLEGHENY COUNTY, PENSYLVANIA

Taxa are listed according to the following format: taxon name, author(s), {(year) collector and number} **global: state ranking** [*Synonyms*] and non-native source. We follow the state (**S**) and global (**G**) ranking systems developed by The Nature Conservancy (1996 version). The global numbers are designated from **1** (critically imperiled) to **5** (secure). Other notations include **SH,** which denotes historical occurrence, and **SR,** which indicates reported without persuasive documentation. Synonyms are included for names not in common usage in the state or regional manuals. In cases where there was more than one specimen present in the Carnegie Museum Herbarium collection, recent collections of current collectors for the western Pennsylvania region were cited.

Families, genera, and specific and infraspecific taxa are arranged alphabetically within vascular plant groups Angiosperms, Equisetophytes, Gymnosperms, Lycophytes, and Polypodiophytes.

ANGIOSPERMS

Acanthaceae

Justicia americana (L.) Vahl, 1994 W.A. Zanol 3074

Aceraceae

Acer campestre L., 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14353 Europe
Acer negundo L. var. *negundo,* 1999 B.L. Isaac and T. Herman 11780
Acer nigrum Michx. f., 1998 K. McGowan and M. Scanlon 155 [*Acer saccharum* (Marsh) ssp. *nigrum* (Michx. f.) Desmarais]
Acer pensylvanicum L., 1929 O.E. Jennings s.n.
Acer rubrum L. var. *rubrum,* 1984 M. Macdonald and K. Stewart LSCW 58
Acer rubrum L. var. *trilobum* Torr. & A. Gray ex K. Koch, 1951 E. Mason s.n.
Acer saccharinum L., 1997 S.A. Thompson and B.L. Isaac 14136
Acer saccharum Marsh. var. *saccharum,* 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15158
Acer spicatum Lam., 1936 O.E. Jennings s.n.

Acoraceae

Acorus americanus (Raf.) Raf., 1989 S.A. Thompson 6862 G5:S1 [*Acorus calamus* L. var. *americanus* (Raf.) H.D. Wulff.]
Acorus calamus L., 1948 E. Mason s.n.

Alismataceae

Alisma subcordatum Raf., 1991 W.A. Zanol 825 [*Alisma plantago-aquatica* L. var. *parviflorum* (Pursh) Torr.]
Sagittaria australis (J.G. Sm.) Small, 1922 A.B. Lord s.n. [*Sagittaria engelmanniana* J.G. Sm. ssp. *longirostra* auct. non Micheli]
Sagittaria graminea Michx., 1991 B.L. Isaac and J.A. Isaac and E. Allen 3511
Sagittaria latifolia Willd., 1975 J.M. Eggers 14
Sagittaria rigida Pursh., 1940 O.E. Jennings s.n.

Amaranthaceae

Amaranthus albus L., 1986 A.W. Cusick 25787 [*Amaranthus albus* L. var. *pubescens* (Uline & Bray) Fern.]
Amaranthus arenicola I.M. Johnston, 1946 W.E. Buker s.n.
Amaranthus blitoides S. Wats. s.n., Exotic
Amaranthus blitum L. var. *emarginatus* (Moq. ex Uline & Bray) comb., 1993 W.A. Zanol 2066 [*Amaranthus lividus* L.]
Amaranthus cruentus L., 1946 W.E. Buker s.n. Central America
Amaranthus graecizans L., 1913 J. Bright s.n. Mediterranean
Amaranthus hybridus L., 1990 W.A. Zanol 339
Amaranthus hypochondriacus L., 1891 J.A. Shafer s.n. Africa
Amaranthus powellii S. Wats. ssp. *powellii,* 1889 J.A. Shafer s.n.
Amaranthus retroflexus L., 1968 W.E. Buker s.n. Tropical America
Amaranthus tuberculatus (Moq.) Sauer, 1922 J. Bright s.n.

Anacardiaceae

Rhus aromatica Ait. var. *aromatica,* 1947 W.E. Buker s.n.
Rhus copallinum L., 1910 A.E. Ortman s.n.
Rhus glabra L., 1945 L.K. Henry s.n.
Rhus typhina L., 1998 K. McGowan and M. Scanlon 220
Toxicodendron radicans (L.) Kuntze ssp. *negundo* (Greene) Gillis, 1998 K. McGowan and M. Scanlon 179
Toxicodendron vernix (L.) Kuntze, 1915 O.E. Jennings s.n.

Annonaceae

Asimina triloba (L.) Dunal, 1950 L.K. Henry s.n.

Apiaceae

Aegopodium podagraria L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13560 Eurasia [*Aegopodium podagraria* L. var. *variegatum* Bailey]
Aethusa cynapium L., 1916 N. McCallum s.n. Eurasia
Anethum graveolens L., 1945 W.E. Buker s.n. Europe
Angelica atropurpurea L., 1933 C.M. Boardman s.n. [*Angelica atropurpurea* L. var. *occidentalis* Fassett]
Angelica venenosa (Greenway) Fern., 1945 W.E. Buker s.n.
Chaerophyllum procumbens (L.) Crantz var. *procumbens*, 1989 C.W. Bier s.n.
Cicuta maculata L. var. *maculata*, 1991 W.A. Zanol 805
Conium maculatum L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14381 Europe
Cryptotaenia canadensis (L.) DC., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13599
Daucus carota L., 2002 H. George s.n. Eurasia
Erigenia bulbosa (Michx.) Nutt., 1922 O.E. Jennings s.n. G5:S4
Foeniculum vulgare P. Mill., 1889 J.A. Shafer s.n. Southern Europe
Heracleum maximum Bartr., 1997 S.A. Thompson and M. Sally 13513 [*Heracleum lanatum* Michx.]
Hydrocotyle americana L., 1930 W.R. VanDersal 1731
Osmorhiza claytonii (Michx.) C.B. Clarke, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14327
Osmorhiza longistylis (Torr.) DC., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14328
Oxypolis rigidior (L.) Raf., 1912 J. Bright s.n. G5:S2
Pastinaca sativa L., 1997 S.A. Thompson and B.L. Isaac 13645 Eurasia
Sanicula canadensis L. var. *canadensis*, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15150
Sanicula marilandica L., 1969 W.E. Buker s.n.
Sanicula odorata (Raf.) K.M. Pryer & L.R. Phillippe, 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14356 [*Sanicula gregaria* Bickn.]
Sanicula trifoliata Bickn., 1997 S.A. Thompson and M. Sally 13504
Taenidia integerrima (L.) Drude, 1946 W.E. Buker s.n.
Thaspium barbinode (Michx.) Nutt., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2265
Thaspium trifoliatum (L.) A. Gray var. *aureum* Britt., 1997 B.L. Isaac and J.A. Isaac 9603
Zizia aptera (A. Gray) Fern., 1969 W.E. Buker s.n.
Zizia aurea (L.) W.D.J. Koch, 1991 W.A. Zanol 479

Apocynaceae

Apocynum androsaemifolium L., 1991 W.A. Zanol 779
Apocynum cannabinum L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15099
Apocynum x *floribundum* Greene (pro sp.), 1917 B.H. Patterson s.n. [*Apocynum medium* Greene]
Vinca minor L., 1998 K. McGowan and M. Scanlon 8 Europe

Aquifoliaceae

Ilex montana Torr. & A. Gray ex A. Gray, 1926 H.W. Graham s.n.
Ilex opaca Ait. var. *opaca*, 1938 R.J. Templeton and W.C. Grimm s.n. G5:S2
Ilex verticillata (L.) A. Gray, 1944 O.E. Jennings s.n.

Araceae

Arisaema dracontium (L.) Schott, 1942 O.E. Jennings s.n.
Arisaema triphyllum (L.) Schott ssp. *pusillum* (Peck) Huttleston, 1940 L.K. Henry s.n.
Arisaema triphyllum (L.) Schott ssp. *stewardsonii* (Britt.) Huttleston, 1945 O.E. Jennings s.n.
Arisaema triphyllum (L.) Schott ssp. *triphyllum*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech and S. Grund 14344
Symplocarpus foetidus (L.) Salisb. ex Nutt., 1991 W.A. Zanol 425

Araliaceae

Aralia hispida Vent., 1908 O.E. Jennings s.n.
Aralia nudicaulis L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14320
Aralia racemosa L. ssp. *racemosa*, 1997 S.A. Thompson and B.L. Isaac and R. Goto and T. Collins 14205
Aralia spinosa L., 1997 S.A. Thompson and B.L. Isaac 14199
Eleutherococcus sieboldianus (Makino) Koidzumi, 2002 B.L. Isaac and J.A. Isaac 14373 Japan [*Eleutherococcus pentaphyllus* auct. non (Sieb. & Zucc.) Nakai]
Panax quinquefolius L., 1912 J. Bright 22
Panax trifolius L., 1920 O.E. Jennings and L.C. Denise s.n.

Aristolochiaceae

Asarum canadense L., 1945 O.E. Jennings s.n. [*Asarum canadense* L. var. *acuminatum* Ashe]
Endodeca serpentaria (L.) Raf., 1937 O.E. Jennings s.n. [*Aristolochia serpentaria* L.]
Isotrema macrophyllum (Lam.) C.F. Reed, 2001 J.A. Isaac 13621 [*Aristolochia macrophylla* Lam.]

Asclepiadaceae

Asclepias exaltata L., 1945 L.K. Henry s.n.
Asclepias incarnata L. ssp. *incarnata*, 1998 K. McGowan and M. Scanlon 309
Asclepias purpurascens L., 1998 S.A. Thompson 14911
Asclepias quadrifolia Jacq., 1967 L.K. Henry s.n.
Asclepias syriaca L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15207 [*Asclepias syriaca* L. var. *kansana* (Vail) Palmer & Steyermark]
Asclepias tuberosa L. ssp. *tuberosa*, 2001 S.N. Costabile 16
Asclepias viridiflora Raf., 1949 E. Mason s.n.
Matelea obliqua (Jacq.) Woods., 1896 W.J. McAdams s.n. G4?:S1

Asteraceae

Achillea millefolium L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13607 Europe
Ageratina altissima (L.) King & H.E. Robins. var. *altissima*, 2002 S.P. Grund and M.L. Speedy 2898 [*Eupatorium rugosum* Houtt.]
Ambrosia artemisiifolia L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15125
Ambrosia trifida L., 1990 W.A. Zanol 226
Anaphalis margaritacea (L.) Benth., 1944 L.K. Henry s.n.

Antennaria howellii Greene ssp. *neodioica* (Greene) Bayer, 1992 W.A. Zanol 1221
Antennaria howellii Greene ssp. *petaloidea* (Fern.) Bayer, 1915 B.H. Patterson [*Antennaria neodioica* Greene ssp. *petaloidea* (Fern.) Bayer & Stebbins]
Antennaria parlinii Fern. ssp. *fallax* (Greene) Bayer & Stebbins, 1925 J. Bright s.n.
Antennaria parlinii Fern. ssp. *parlinii,* 1950 L. News s.n. [*Antennaria plantaginifolia* (L.) Richards var. *parlinii* (Fern.) Cronq.]
Antennaria plantaginifolia (L.) Richards., 1946 D. Benzenhoefer
Bidens aristosa (Michx.) Britt., 1986 A.W. Cusick 25792 [*Bidens polylepsis* Blake]
Antennaria virginica Stebbins, 1949 W.E. Buker s.n. G4:S3 [*Antennaria virginica* Stebbins var. *argillicola* Stebbins]
Anthemis cotula L., 1994 W.A. Zanol 2441 Europe
Arctium lappa L., 1998 K. McGowan and M. Scanlon 353 Eurasia [*Arctium vulgare* (Hill) Evans]
Arctium minus (Hill) Bernh., 1994 W.A. Zanol 3469 Eurasia
Arnoglossum atriplicifolium (L.) H.E. Robins., 1912 J. Bright 27 [*Cacalia atriplicifolia* L.]
Arnoglossum reniforme (Hook) H.E. Robins., 1919 O.E. Jen-nings s.n. G4:S1 [*Cacalia muehlenbergii* (Schultz-Bip) Fern.]
Artemisia annua L., 1986 A.W. Cusick 25790 Eurasia
Artemisia biennis Willd., 1889 J. Furgeson s.n. Europe
Artemisia ludoviciana Nutt. ssp. *ludoviciana,* 1967 W.E. Buker s.n. [*Artemisia ludoviciana* Nutt. var. *gnaphalodes* (Nutt.) Torr. & A. Gray]
Artemisia vulgaris L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15171 Eurasia
Bellis perennis L., 2002 B.L. Isaac and J.A. Isaac 14335 Europe
Bidens bipinnata L., 1997 S.A. Thompson and B.L. Isaac 14202
Bidens cernua L., 1993 W.A. Zanol 2072
Bidens frondosa L., 1998 K. McGowan and M. Scanlon 389
Bidens tripartita L., 1993 W.A. Zanol 2150
Bidens vulgata Greene, 1944 L.K. Henry s.n.
Boltonia asteroides (L.) L'Her var. *asteroides,* 1988 E. York 355 G5:S1
Brickellia eupatorioides (L.) Shinners var. *eupatorioides,* 1945 E. Mason s.n.
Calendula officinalis L., 1966 W.E. Buker s.n. Southern Europe
Centaurea cyanus L., 1992 G.H. Pollack 56 Europe
Centaurea jacea L., 1964 N.R. Farnsworth WP-972 Europe
Centaurea nigra L., 1933 C.T. Agostini s.n. Europe [*Centaurea nigra* L. var. *radiata* DC.]
Centaurea stoebe L. ssp. *micranthos* (Gugler) Hayek, 2000 R.B. Coxe s.n. Europe [*Centaurea biebersteinii* DC.]
Cichorium intybus L., 2002 H. George s.n. Europe
Cirsium altissimum (L.) Spreng., 1944 L.K. Henry s.n.
Cirsium arvense (L.) Scop., 1998 S.A. Thompson 14912 Eurasia
Cirsium discolor (Muhl. ex Willd.) Spreng., 1921 O.E. Jennings s.n.
Cirsium muticum Michx., 1950 D.H. Krouse s.n.
Cirsium pumilum (Nutt.) Spreng., 1991 W.A. Zanol 876
Cirsium vulgare (Savi) Ten., 1997 J.A. Isaac and B.L. Isaac 10178 Eurasia
Conoclinium coelestinum (L.) DC., 1997 S.A. Thompson and B.L. Isaac 14127 G5:S3 [*Eupatorium coelestinum* L.]
Conyza canadensis (L.) Cronq., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15206
Coreopsis lanceolata L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13604
Coreopsis tinctoria Nutt. var. *tinctoria,* 1965 N.R. Farnsworth WP-1144
Coreopsis tripteris L., 1965 W.D. Loub and H.H. Fong WP-1137
Cosmos bipinnatus Cav., 1963 N.R. Farnsworth WP-613 Mexico
Crepis capillaris (L.) Wallr., 1935 O.E. Jennings s.n. Europe
Doellingeria infirma (Michx.) Greene, 1919 O.E. Jennings s.n. [*Aster infirmus* Michx.]
Doellingeria umbellata (P. Mill.) Nees var. *umbellata,* 1966 R.N. Blomster WP-651 [*Aster umbellatus* P. Mill. var. *umbellatus*]
Dyssodia papposa (Vent.) A.S. Hitchc., 2004 B.L. Isaac and J.A. Isaac 18551
Echinacea purpurea (L.) Moench, 1994 W.A. Zanol 3499
Eclipta prostrate (L.) L., 1994 W.A. Zanol 3457
Erechtites hieraciifolius (L.) Raf. ex DC. var. *hieraciifolius,* 1994 W.A. Zanol 3752
Erigeron annuus (L.) Pers., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13566 [*Erigeron annuus* (L.) Pers. var. *discoideus* (Victorin & Rouss.) Cronq.]
Erigeron philadelphicus L. var. *philadelphicus,* 1998 K. McGowan and M. Scanlon 183
Erigeron pulchellus Michx. var. *pulchellus,* 1982 W.E. Buker s.n.
Erigeron strigosus Muhl. ex Willd. var. *strigosus,* 1998 K. McGowan and M. Scanlon 280
Eupatorium altissimum L., 1997 S.A. Thompson and J.E. Rawlins 13898
Eupatorium perfoliatum L., 1998 K. McGowan and M. Scanlon 363
Eupatorium serotinum Michx., 1996 L.L. Smith and R. Hawk 75
Eupatorium sessilifolium L., 1945 L.K. Henry s.n.
Eurybia divaricata (L.) Nesom, 2000 R.B. Coxe s.n. [*Aster divaricatus* L.]
Eurybia macrophylla (L.) Cass., 1945 L.K. Henry s.n. [*Aster macrophyllus* L.]
Eurybia schreberi (Nees) Nees, 1991 W.A. Zanol 866 [*Aster schreberi* Nees]
Euthamia graminifolia (L.) Nutt., 1998 B.L. Isaac and J.A. Isaac 11657 [*Solidago graminifolia* (L.) Salisb.]
Eutrochium fistulosum (Barratt) E. Lamont, 1998 K. McGowan and M. Scanlon 288 [*Eupatorium fistulosum* Barratt]
Eutrochium maculatum (L.) E. Lamont var. *maculatum,* 1990 W.A. Zanol 225 [*Eupatorium maculatum* L. var. *maculatum*]
Eutrochium purpureum (L.) E. Lamont var. *purpureum,* 1994 W.A. Zanol 3456 [*Eupatorium purpureum* L. var. *purpureum*]
Galinsoga quadriradiata Cav., 1997 S.A. Thompson and B.L. Isaac 13869 Central and South America
Gamochaeta purpurea (L.) Cabrera, 1902 J.A. Shafer s.n. [*Gnaphalium purpureum* L. var. *purpureum*]

Gnaphalium uliginosum L., 1993 W.A. Zanol 2064 Europe
Hasteola suaveolens (L.) Pojark., 1991 W.A. Zanol 881
Helenium autumnale L., 1990 W.A. Zanol 306
Helenium flexuosum Raf., 1950 M. McCrackan s.n.
Helianthus annuus L., 1990 W.A. Zanol 187
Helianthus decapetalus L., 1990 W.A. Zanol 1
Helianthus divaricatus L., 1994 W.A. Zanol 3485
Helianthus giganteus L., 1994 W.A. Zanol 3484
Helianthus grosseserratus Martens, 1914 J. Bright s.n.
Helianthus hirsutus Raf., 1982 W.E. Buker s.n. G5:S2
Helianthus microcephalus Torr. & A. Gray, 1994 W.A. Zanol 3749 G5:S3
Helianthus mollis Lam., 1931 Turner s.n.
Helianthus strumosus L., 1962 N.R. Farnsworth WP-43
Helianthus tuberosus L., 1994 W.A. Zanol 3463
Helianthus x laetiflorus Pers. (pro sp.), 1916 O.E. Jennings s.n.
Heliopsis helianthoides (L.) Sweet var. *helianthoides*, 2001 S.N. Costabile 27
Hieracium aurantiacum L., 2001 S.N. Costabile 13 Europe
Hieracium caespitosum Dumort., 1998 K. McGowan and M. Scanlon 209 Europe
Hieracium lachenalii K.C. Gmel., 1950 W.E. Buker s.n. Europe
Hieracium paniculatum L., 1945 W.E. Buker s.n.
Hieracium piloselloides Vill., 1991 W.A. Zanol 705 Europe
Hieracium scabrum Michx., 1998 B.L. Isaac and J.A. Isaac 11645
Hieracium venosum L., 1945 L.K. Henry s.n.
Hypochaeris radicata L., 1947 W.E. Buker s.n. Eurasia
Inula helenium L., 1902 J.E. Winner s.n. Europe
Krigia biflora (Walt.) Blake var. *biflora*, 1946 W.E. Buker s.n.
Lactuca biennis (Moench) Fern., 1990 E. Bright 10
Lactuca canadensis L., 1997 S.A. Thompson and B.L. Isaac 14159
Lactuca floridana (L.) Gaertn., 1969 W.E. Buker s.n.
Lactuca saligna L., 1947 L.K. Henry s.n. Europe
Lactuca sativa L., 1963 N.R. Farnsworth WP-440 Mediterranean
Lactuca serriola L., 1994 W.A. Zanol 3747 Europe
Lapsana communis L., 1997 S.A. Thompson and J.E. Rawlins and R. Androw 13521 Europe
Leontodon autumnalis L., 1935 O.E. Jennings s.n. Europe
Leontodon saxatilis Lam. ssp. *saxatilis*, 1929 F.L. Hower s.n. Europe [*Leontodon taraxcoides* (Vill.) Merat]
Leucanthemum vulgare Lam., 1985 M. Macdonald LSCW116 Europe [*Chrysanthemum leucanthemum* L.]
Matricaria discoidea DC., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13563 Exotic [*Matricaria matricarioides* auct. non (Less.) Porter]
Onopordum acanthium L., 1898 J.A. Shafer s.n. Eurasia
Packera aurea (L.) A. & D. Löve, 1998 K. McGowan and M. Scanlon 121 [*Senecio aureus* L.]
Packera obovata (Muhl. ex Willd.) W.A. Weber, 1965 N.R. Farnsworth WP-1027 [*Senecio obovatus* Muhl. ex Willd.]
Picris hieracioides L. ssp. *hieracioides*, 1918 J. Bright s.n. Eurasia
Polymnia canadensis L., 1945 E. Mason s.n. G5:SNR
Prenanthes alba L., 1959 L.K. Henry s.n.
Prenanthes altissima L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15182
Prenanthes crepidinea Michx., 1932 J. Bright 7691
Pseudognaphalium macounii (Greene) Kartesz, 1898 J.A. Shafer s.n. [*Gnaphalium macounii* Greene]
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt ssp. *obtusifolium*, 1994 W.A. Zanol 3753 [*Gnaphalium obtusifolium* L.]
Ratibida pinnata (Vent.) Barnh., 1954 O.E. Jennings s.n. G5:S1
Rudbeckia fulgida Ait. var. *speciosa* (Wenderoth) Perdue, 1928 J. Bright 648 G5:S3 [*Rudbeckia fulgida* Ait. var. *sullivantii* (C.L. Boynt. & Beadle) Cronq.]
Rudbeckia hirta L. var. *hirta*, 1998 K. McGowan and M. Scanlon 241
Rudbeckia laciniata L. var. *laciniata*, 1998 K. McGowan and M. Scanlon 346
Rudbeckia triloba L. var. *triloba*, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15208
Senecio vulgaris L., 1993 W.A. Zanol 2156 Eurasia
Sericocarpus asteroides (L.) B.S.P., 2002 S.P. Grund and M.L. Speedy 2894
Silphium asteriscus L. var. *trifoliatum* (L.) J.A. Clevinger, 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2280 [*Silphium trifoliatum* L.]
Silphium laciniatum L., 1889 C.C. Mellor s.n.
Silphium perfoliatum L. var. *perfoliatum*, 1953 L.K. Henry and D.E. Long s.n.
Smallanthus uvedalius (L.) Mackenzie ex Small, 1903 B.H. Patterson s.n. G4G5:SNR [*Polymnia uvedalia* (L.) L.]
Solidago altissima L. ssp. *altissima*, 2003 C. Tracey 2003-0012
Solidago arguta Ait. var. *arguta*, 1917 B.H. Patterson s.n.
Solidago bicolor L., 2000 R.B. Coxe s.n.
Solidago caesia L. var. *caesia*, 1998 K. McGowan and M. Scanlon 392 [*Solidago caesia* L. var. *axillaris* (Pursh) A. Gray]
Solidago canadensis L. var. *canadensis*, 1990 W.A. Zanol 185
Solidago canadensis L. var. *hargeri* Fern., 1939 R.W. Little s.n.
Solidago flexicaulis L., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14120
Solidago gigantean Ait., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14099
Solidago juncea Ait., 2000 R.B. Coxe s.n.
Solidago nemoralis Ait. var. *nemoralis*, 1998 B.L. Isaac and J.A. Isaac 11652
Solidago patula Muhl. ex Willd. var. *patula*, 1950 D.H. Krouse s.n.
Solidago rugosa P. Mill. ssp. *aspera* var. *aspera* (Ait.) Cronq., 1965 N.R. Farnsworth WP-542
Solidago rugosa P. Mill. ssp. *rugosa* var. *rugosa* (Pursh) Fern., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14098
Solidago speciosa Nutt. ssp. *speciosa* var. *speciosa*, 1927 E. Wallace s.n. G5T5?:SNR
Solidago squarrosa Muhl., 1990 W.A. Zanol 355
Solidago ulmifolia Muhl. ex Willd. var. *ulmifolia*, 1996 L.L. Smith and R. Hawk 78
Sonchus asper (L.) Hill, 1994 W.A. Zanol 3766 Europe

Sonchus arvensis L. ssp. *arvensis,* 1945 W.E. Buker s.n. Europe

Sonchus arvensis L. ssp. *uliginosus* (Bieb.) Nyman, 1994 W.A. Zanol 3494 Europe

Sonchus oleraceus L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13589 Europe

Symphyotrichum cordifolium (L.) Nesom, 1997 S.A. Thompson and B.L. Isaac 14166 [*Aster cordifolius* L.]

Symphyotrichum drummondii (Lindl.) Nesom var. *drummondii,* 1912 B.H. Patterson s.n. G5:SH [*Aster drummondii* Lindl.]

Symphyotrichum laeve (L.) A. & D. Löve var. *laeve,* 1944 L.K. Henry s.n. [*Aster laevis* L. var. *laevis*]

Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum* var. *interior* (Wieg.) Nesom, 1921 M. Knauz s.n. [*Aster lanceolatus* Willd. ssp. *interior* (Wieg.) A.G. Jones]

Symphyotrichum lanceolatum (Willd.) Nesom ssp. *lanceolatum* var. *lanceolatum,* 1990 W.A. Zanol 119 [*Aster simplex* Willd. var. *simplex*]

Symphyotrichum lateriflorum (L.) A. & D. Löve var. *horizontale* (Desf.) Nesom, 1944 L.K. Henry s.n. [*Aster lateriflorus* (L.) Britt. var. *pendulus* (Ait.) Burgess]

Symphyotrichum lateriflorum (L.) A. & D. Löve var. *lateriflorum,* 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15174 [*Aster lateriflorus* (L.) Britt.]

Symphyotrichum novae-angliae (L.) Nesom, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15211 [*Aster novae-angliae* L.]

Symphyotrichum oblongifolium (Nutt.) Nesom, 1965 N.R. Farnsworth WP-981 [*Aster oblongifolius* Nutt.]

Symphyotrichum patens (Ait.) Nesom var. *patens,* 1914 B.H. Patterson s.n. [*Aster patens* Ait.]

Symphyotrichum phlogifolium (Muhl. Ex Willd.) Nesom, 1922 J. Bright s.n. [*Aster phlogifolium* Muhl. ex Willd.]

Symphyotrichum pilosum (Willd.) Nesom var. *pilosum,* 1998 B.L. Isaac and J.A. Isaac 11650 [*Aster pilosus* Willd.]

Symphyotrichum pilosum (Willd.) Nesom var. *pringlei* (A. Gray) Nesom, 1966 R.N. Blomster WP-652 [*Aster pilosus* Willd. var. *pringlei* (A. A. Gray) S.F. Blake]

Symphyotrichum praealtum (Poir.) Nesom var. *angustior* (Wieg.) Nesom, 1998 B.L. Isaac and J.A. Isaac 11658 G5:S3 [*Aster praealtus* Poir. var. *angustior* Wieg.]

Symphyotrichum praealtum (Poir.) Nesom var. *praealtum,* 1990 W.A. Zanol 379 [*Aster praealtus* Poir.]

Symphyotrichum prenanthoides (Muhl. ex Willd.) Nesom, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15173 [*Aster prenanthoides* Muhl. Ex Willd.]

Symphyotrichum puniceum (L.) A. & D. Löve var. *puniceum,* 1990 W.A. Zanol 370 [*Aster puniceus* L.]

Symphyotrichum shortii (Lindl.) Nesom, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15172 [*Aster shortii* Lindl.]

Symphyotrichum undulatum (L.) Nesom, 1949 E. Mason s.n. [*Aster undulatum* L.]

Symphyotrichum urophyllum (Lindl.) Nesom, 1966 R.N. Blomster WP-659 [*Aster urophyllus* Lindl.]

Tanacetum parthenium (L.) Schultz- Bip., 2001 J.A. Isaac 13624 Europe [*Chrysanthemum parthenium* (L.) Bernh.]

Tanacetum vulgare L., 1994 W.A. Zanol 2862 Europe

Taraxacum laevigatum (Willd.) DC., 1922 J. Bright s.n. Eurasia

Taraxacum officinale G.H. Weber ex Wiggers, 1998 S.A. Thompson and M. Burroughs 14395 Eurasia

Tragopogon dubius Scop., 1997 B.L. Isaac and J.A. Isaac 9610 Europe

Tragopogon lamottei Rouy, 1965 N.R. Farnsworth WP-1134 Europe [*Tragopogon pratensis* L.]

Tussilago farfara L., 1998 B.L. Isaac and M. Rosenberger 10210 Eurasia

Verbesina alternifolia (L.) Britt. ex Kearney, 1997 S.A. Thompson and J.E. Rawlins 13890

Vernonia gigantea (Walt.) Trel., 1998 K. McGowan and M. Scanlon 342

Vernonia noveboracensis (L.) Michx., 1990 W.A. Zanol 245

Xanthium strumarium L., 1997 S.A. Thompson and B.L. Isaac 14170

Azollaceae

Azolla caroliniana Willd., 1996 J. Wagner and P. Youngand s.n.

Balsaminaceae

Impatiens capensis Meerb., 2001 S.N. Costabile 17

Impatiens pallida Nutt., 1998 K. McGowan and M. Scanlon 299

Berberidaceae

Berberis thunbergii DC., 1998 K. McGowan and M. Scanlon 291 Japan

Berberis vulgaris L., 1939 W.C. Grimm and B. McCluske s.n. Europe

Caulophyllum thalictroides (L.) Michx., 1997 S.A. Thompson and M. Sally 13497

Jeffersonia diphylla (L.) Pers., 1945 H.D. Gill s.n.

Podophyllum peltatum L., 1998 K. McGowan and M. Scanlon 101

Betulaceae

Alnus serrulata (Ait.) Willd., 2004 C. Tracey and P.J. Gruszka and M.B. Steisslinger 2004-0030 [*Alnus serrulata* (Ait.) Willd. var. *subelliptica* Fern.]

Betula alleghaniensis Britt., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15145

Betula lenta L., 1997 S.A. Thompson and B.L. Isaac 14198

Betula papyrifera Marsh. var. *papyrifera,* 1982 W.E. Buker s.n.

Carpinus caroliniana Walt. ssp. *virginiana* (Marsh.) Furlow, 1998 K. McGowan and M. Scanlon 219

Corylus americana Marsh., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14346

Corylus cornuta Marsh. var. *cornuta,* 1922 J. Bright s.n.

Ostrya virginiana (P. Mill.) K. Koch, 1998 K. McGowan and B.L. Isaac and M. Scanlon 28

Bignoniaceae

Campsis radicans (L.) Seem. ex Bureau, 1906 J.A. Shafer s.n.

Catalpa bignonioides Walt., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13449

Catalpa speciosa Warder ex Engelm., 1998 S.A. Thompson and B.L. Isaac 14941

Boraginaceae

Buglossoides arvensis (L.) I.M. Johnston, 1970 W.E. Buker s.n. Eurasia

Cymbalaria muralis P.G. Gaetrn., B. Mey., & Schreb, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13601 Mediterranean

Cynoglossum officinale L., 1913 J. Bright s.n. Eurasia

Cynoglossum virginianum L. var. *virginianum*, 1947 W.E. Buker s.n.

Echium pustulatum Sibthorp & Sm., 1997 S.A. Thompson and B.L. Isaac 14194 Europe [*Echium vulgare* L. var. *pustulatum* (Sibthorp & Sm.) Coincy]

Echium vulgare L., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13457 Europe

Hackelia virginiana (L.) I.M. Johnston, 1997 S.A. Thompson and B.L. Isaac 13880

Heliotropium europaeum L., 1973 W.E. Buker s.n. Europe

Lappula squarrosa (Retz.) Dumort, 1982 W.E. Buker s.n. Eurasia [*Lappula echinata* Gilib. var. *echinata*]

Lithospermum canescens (Michx.) Lehm., 1954 M.C. Bowman s.n. G5:S2

Lithospermum latifolium Michx., 1891 A. Koenig s.n. G4:S4

Mertensia virginica (L.) Pers. ex Link, 1991 W.A. Zanol 453

Myosotis arvensis (L.) Hill, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14317 Eurasia

Myosotis laxa Lehm., 2000 R.B. Coxe s.n.

Myosotis macrosperma Engelm., 1998 K. McGowan and M. Scanlon 106

Myosotis scorpioides L., 1990 W.A. Zanol 102 Europe

Myosotis verna Nutt., 1946 W.E. Buker s.n. [*Myosotis virginica* auct. non (L.) B.S.P.]

Symphytum officinale L., 1994 W.A. Zanol 3486 Eurasia

Brassicaceae

Alliaria petiolata (Bieb.) Cavara & Grande, 2002 M.L. Young and B.R. Swiech 2 Europe

Arabidopsis lyrata (L.) O'Kane & Al-Shehbaz ssp. *lyrata*, 1997 B.L. Isaac and J.A. Isaac 9622 [*Arabis lyrata* L.]

Arabidopsis thaliana (L.) Heynh., 2002 B.L. Isaac and J.A. Isaac1 4370 Eurasia

Armoracia rusticana P.G. Gaertn., B. Mey, Scherb., 1941 E. Mason s.n. Eurasia

Barbarea vulgaris Ait. f., 1998 K. McGowan and M. Scanlon 127 Eurasia

Berteroa incana (L.) DC., 1970 W.E. Buker s.n. Europe

Boechera burkii (Porter) Windham & Al-Shehbaz, 1929 O.E. Jennings s.n. [*Arabis laevigata* (Muhl. ex Willd.) Poir. var. *burkii* Porter]

Boechera canadensis Al-Shehbaz, 1947 E. Mason s.n. [*Arabis canadensis* L.]

Boechera laevigata (Muhl. ex Willd.) Al-Shehbaz, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14377 [*Arabis laevigata* (Muhl. ex Willd.) Poir.]

Boechera shortii (Fern.) Al-Shehbaz, 1964 W.E. Buker s.n. [*Arabis shortii* (Fern.) Gleason]

Brassica juncea (L.) Czern., 1965 N.R. Farnsworth WP-1052 Eurasia

Brassica nigra (L.) W.D.J. Koch, 1992 W.A. Zanol 1111 Eurasia

Brassica rapa L. var. *rapa*, 1946 W.E. Buker s.n. Europe [*Brassica rapa* L. ssp. *olifera* DC.]

Camelina microcarpa Andrz. ex DC., 1979 D.E. Boufford and E.W. Wood and W.E. Buker 21123 Eurasia

Capsella bursa-pastoris (L.) Medik., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14309 Eurasia

Cardamine angustata O.E. Shulz, 1947 L. Black 462

Cardamine bulbosa (Schreb. ex Muhl.) B.S.P., 1991 W.A. Zanol 535

Cardamine concatenata (Michx.) Sw., 1999 B.L. Isaac and T. Herman 11773

Cardamine diphylla (Michx.) Wood, 1997 J.D. Wagner 1497

Cardamine douglassii Britt., 1922 O.E. Jennings s.n.

Cardamine flexuosa With., 1996 A.W. Cusick 33096 Europe

Cardamine hirsuta L., 1998 K. McGowan and M. Scanlon 95 Europe

Cardamine impatiens L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14304 Europe

Cardamine parviflora L. var. *arenicola* (Britt.) O.E. Schulz, 1901 J.A. Shafer 300

Cardamine pensylvanica Muhl. ex Willd., 2002 B.L. Isaac and J.A. Isaac 14384

Cardamine rotundifolia Michx., 1992 W.A. Zanol 978

Cardaria draba (L.) Desv., 1940 W. Hutchman s.n. Eurasia

Conringia orientalis (L.) Dumort., 1920 N. McCallum s.n. Eurasia

Diplotaxis tenuifolia (L.) DC., 1971 G. Wallace s.n. Europe

Draba verna L., 1931 S.H. Shaw s.n. Europe

Erysimum cheiranthoides L., 1901 J.A. Shafer 134 Eurasia

Hesperis matronalis L., 2001 S.N. Costabile 1 Europe

Iberis umbellata L., 1966 W.E. Buker s.n. Europe

Iodanthus pinnatifidus (Michx.) Steud., 1913 O.E. Jennings s.n. G5:S1

Lepidium campestre (L.) Ait. f., 1998 K. McGowan and M. Scanlon 175 Eurasia

Lepidium densiflorum Schrad. var. *densiflorum*, 1933 J. Bright 8853

Lepidium virginicum L. var. *virginicum*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13598

Lobularia maritima (L.) Desv., 1994 A.W. Cusick 31799 Mediterranean

Lunaria annua L., 1988 S.A. Thompson and F. Wright 5081 Europe

Lunaria rediviva L., 1975 W.E. Buker s.n. Europe

Microthlaspi perfoliatum (L.) F.K. Mey, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13557 Eurasia [*Thlaspi perfoliatum* L.]

Nasturtium officinale Ait. f., 2000 R.B. Coxe s.n. [*Rorippa nasturtium-aquaticum* (L.) Hayek]

Raphanus raphanistrum L., 1945 W.E. Buker s.n. Mediterranean

Raphanus sativus L., 1925 E.H. Graham s.n. Mediterranean

Rorippa palustris (L.) Bess. ssp. *fernaldiana* (Butters & Abbe) Jonsell, 1993 W.A. Zanol 2074

Rorippa palustris (L.) Bess. ssp. *hispida* (Desv.) Jonsell, 1916 J. Bright s.n.

Rorippa sylvestris (L.) Bess., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13492 Europe

Sinapis arvensis L., 1964 N.R. Farnsworth WP-756 Mediterranean

Sisymbrium altissimum L., 1993 F.W. Wright Jr. 106 Eurasia

Sisymbrium officinale (L.) Scop. 1945 W.E. Buker s.n. Europe [*Sisymbrium officinale* (L.) Scop. var. *leiocarpum* DC.]

Thlaspi arvense L., 1994 W.A. Zanol 2432 Europe

Turritis glabra L., 1946 W.E. Buker s.n. [*Arabis glabra* (L.) Bernh.]

Buddlejaceae

Buddleja davidii Franch., 1997 S.A. Thompson and B.L. Isaac 13632 China

Cactaceae

Opuntia humifusa (Raf.) Raf., 1944 O.E. Jennings s.n. G5:S3

Callitrichaceae

Callitriche heterophylla Pursh ssp. *heterophylla*, 1924 J. Bright s.n.

Callitriche palustris L., 1913 J. Bright s.n. [*Callitriche verna* L. var. *verna*]

Callitriche terrestris Raf. Emend Torr., 1964 L.K. Henry s.n.

Calycanthaceae

Calycanthus floridus L. var. *floridus*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14380

Campanulaceae

Campanula aparinoides Pursh, 1932 C.M. Hepner s.n.

Campanula rapunculoides L., 1988 E. Lobdell 79 Eurasia

Campanula rotundifolia L., 1918 J. Bright s.n.

Campanulastrum americanum (L.) Small, 1998 K. McGowan and M. Scanlon 317 [*Campanula americana* L.]

Lobelia cardinalis L., 1925 J. Bright s.n.

Lobelia inflata L., 1998 K. McGowan and M. Scanlon 265

Lobelia siphilitica L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15202

Lobelia spicata Lam. var. *spicata*, 1982 S.A. Thompson and W.E. Buker 460

Triodanis perfoliata (L.) Nieuwl., 1991 W.A. Zanol 589

Cannabaceae

Humulus japonicus Sieb. & Zucc., 1997 S.A. Thompson and B.L. Isaac 14126 Asia

Humulus lupulus L. var. *lupuloides* E. Small, 1932 G.K. Jennings and O.E. Jennings s.n.

Capparaceae

Cleome hassleriana Chod., 1946 W.E. Buker s.n. Tropical America

Cleome spinosa Jacq., 1898 J.A. Shafer s.n.

Polanisia dodecandra (L.) DC. ssp. *dodecandra*, 1961 H. Roslund s.n.

Polanisia dodecandra (L.) DC. ssp. *trachysperma* (Torr. & A. Gray) Iltis, 1932 C.M. Boardman s.n.

Caprifoliaceae

Diervilla lonicera P. Mill., 1945 W.E. Buker and M. Henrici s.n.

Lonicera canadensis Bartr. ex Marsh., 1945 L.K. Henry s.n.

Lonicera dioica L., 1912 J. Bright s.n. [*Lonicera dioica* L. var. *glaucescens* (Rydb.) Butters]

Lonicera japonica Thunb., 2001 S.N. Costabile 12 Asia

Lonicera maackii (Rupr.) Herder, 2002 B.L. Isaac and J.A. Isaac 14385 Asia

Lonicera morrowii A. Gray, 2002 S.P. Grund and M.L. Speedy 2899 Japan

Lonicera sempervirens L., 1945 W.E. Buker s.n.

Lonicera tatarica L., 2002 B.L. Isaac and J.A. Isaac 14337 Eurasia

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15085 [*Sambucus canadensis* L.]

Sambucus nigra L. ssp. *nigra*, 1911 D.R. Sumstine s.n. Exotic [*Sambucus nigra* L. var. *laciniata* L.]

Sambucus racemosa L. var. *racemosa*, 1987 F.H. Utech 87-045 [*Sambucus racemosa* L. ssp. *pubens* (Michx.) House]

Symphoricarpos albus (L.) Blake var. *laevigatus* (Fern.) Blake, 1920 O.E. Jennings and L.C. Demoise s.n.

Symphoricarpos orbiculatus Moench, 1958 M. Reynolds s.n.

Triosteum aurantiacum Bickn. var. *glaucescens* Wieg., 1913 O.E. Jennings s.n.

Triosteum aurantiacum Bickn. var. *illinoense* (Wieg.) Palmer & Steyermark, 1998 B.L. Isaac and J.A. Isaac 11756

Triosteum perfoliatum L., 1923 O.E. Jennings s.n.

Viburnum acerifolium L., 1998 S.A. Thompson and B.L. Isaac 14983

Viburnum dentatum L. var. *dentatum*, 2002 M.L. Young and B.R. Swiech 8

Viburnum dentatum L. var. *lucidum* Ait., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15112 [*Viburnum recognitum* Fern.]

Viburnum dilatatum Thunb., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14114 Asia

Viburnum lantana L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14367 China

Viburnum lentago L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15100

Viburnum opulus L. var. *opulus*, 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14118 Eurasia

Viburnum plicatum Thunb., 2002 B.L. Isaac and J.A. Isaac 14371 Asia

Viburnum prunifolium L., 1997 B.L. Isaac and M.A. Rosenberger 10169

Viburnum rafinesquianum J.A. Schultes, 1920 O.E. Jennings s.n.

Viburnum sieboldii Miq., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14319 Japan

Caryophyllaceae

Agrostemma githago L., 1970 W.E. Buker s.n. Europe

Arenaria serpyllifolia L. var. *serpyllifolia*, 1997 S.A. Thompson 13439 Europe

Cerastium arvense L. ssp. *arvense*, 1888 J. McCandless s.n.

Cerastium arvense L. ssp. *strictum* (L.) Ugborogho, B.H. Patterson s.n.

Cerastium fontanum Baumg. ssp. *vulgare* (Hartman) Greuter & Burdet, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13556 Eurasia [*Cerastium vulgatum* L.]

Cerastium glomeratum Thuill., 1998 K. McGowan and M. Scanlon 192 Eurasia

Cerastium nutans Raf. var. *nutans*, 1947 E. Mason s.n.

Dianthus armeria L., 1998 K. McGowan and M. Scanlon 236 Europe

Dianthus deltoides L., 1991 W.A. Zanol 583 Eurasia
Minuartia glabra (Michx.) Mattf., 1887 J.A. Shafer s.n. G4:S2
Myosoton aquaticum (L.) Moench, 1998 K. McGowan and M. Scanlon 386 Europe
Paronychia canadensis (L.) Wood, 1997 B.L. Isaac and J.A. Isaac 9639
Paronychia fastigiata (Raf.) Fern. var. *fastigiata,* 1947 L.K. Henry s.n.
Sagina procumbens L., 2002 B.L. Isaac and J.A. Isaac 14343 Eurasia
Saponaria officinalis L., 2002 H. George s.n. Europe
Scleranthus annuus L., 1970 W.E. Buker and W.C. Buker s.n. Eurasia
Silene antirrhina L., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13469
Silene caroliniana Walt. ssp. *pensylvanica* (Michx.) Clausen, 1997 B.L. Isaac and J.A. Isaac 9605
Silene coronaria (L.) Clairville, 1901 J.A. Shafer s.n. Europe [*Lychnis coronaria* (L.) Desr.]
Silene dichotoma Ehrh., 1914 B.H. Patterson s.n. Eurasia
Silene dioica (L.) Clairville, 1933 J. Bright 8711 Europe [*Lychnis dioica* L.]
Silene latifolia Poir., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13554 Europe
Silene nivea (Nutt.) Muhl. ex Otth, 1945 L.K. Henry s.n.
Silene noctiflora L., 1912 J. Bright s.n. Europe
Silene stellata (L.) Ait. f., 1963 W.E. Buker s.n.
Silene virginica L., 1991 W.A. Zanol 546
Silene vulgaris (Moench) Garcke, 2002 B.L. Isaac and J.A. Isaac 14367 Europe [*Silene latifolia* (P. Mill.) Britten & Rendle, non Poir.]
Spergula arvensis L., 1915 J. Bright s.n. Eurasia
Stellaria corei Shinners, 2001 J.A. Isaac 13541
Stellaria graminea L., 1998 S.A. Thompson and M. Burroughs 14387 Europe
Stellaria holostea L., 1899 J.A. Shafer s.n. Eurasia
Stellaria longifolia Muhl. ex Willd., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2269
Stellaria pubera Michx., 1927 C.K. Henlen s.n.
Stellaria media (L.) Vill., 1998 S.A. Thompson and J. Rawlins and K. McGowan 14259 Europe
Vaccaria hispanica (P. Mill.) Raushcert, 1947 W.E. Buker s.n. Europe [*Vaccaria pyramidata* Medik.]

Celastraceae

Celastrus orbiculatus Thunb., 2002 B.L. Isaac and J.A. Isaac 14346 China and Japan
Celastrus scandens L., 1940 E. Mason s.n.
Euonymus alatus (Thunb.) Sieb. var. *alatus,* 1998 B.L. Isaac and J.A. Isaac 11601 China and Japan
Euonymus atropurpureus Jacq. var. *atropurpureus,* 1992 W.A. Zanol 1173
Euonymus obovatus Nutt., 1953 W.E. Buker s.n.

Cercidiphyllaceae

Cercidiphyllum japonicum Sieb. & Zucc. ex J. Hoffmann, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13618 Japan

Chenopodiaceae

Atriplex patula L., 1940 O.E. Jennings s.n.
Atriplex prostrata Boucher ex DC., 1947 D.H. Krouse s.n. [*Atriplex patula* L.]
Bassia scoparia (L.) A.J. Scott, 1986 A.W. Cusick 25788 Europe [*Kochia scoparia* (L.) Schrad.]
Chenopodium album L. var. *album,* 1918 O.E. Jennings s.n. Europe [*Chenopodium album* L. var. *lanceolatum* (Muhl. ex Willd.) Coss. & Germ.]
Chenopodium album L. var. *missouriense* (Aellen) I.J. Bassett & C.W. Crompton, 1994 W.A. Zanol 3760
Chenopodium berlandieri Moq. var. *bushianum* (Aellen) Cronq., 1951 W.E. Buker s.n. [*Chenopodium bushianum* Aellen]
Chenopodium glaucum L. var. *glaucum,* 1902 J.A. Shafer 27 Europe
Chenopodium murale L., 1923 J. Bright s.n. Europe
Chenopodium simplex (Torr.) Raf., 1912 J. Bright s.n. [*Chenopodium gigantospermum* Aellen]
Chenopodium standleyanum Aellen, 1900 J.A. Shafer s.n.
Chenopodium urbicum L., 1900 J.A. Shaeffer s.n. Europe
Cycloloma atriplicifolium (Spreng.) Coult., 1923 J. Bright s.n.
Dysphania ambrosioides (L.) Mosyakin & Clemants, 1993 W.A. Zanol 2071 Tropical America [*Chenopodium ambrosioides* L.]
Dysphania botrys (L.) Mosyakin & Clemants, 1997 S.A. Thompson and B.L. Isaac 14258 Europe [*Chenopodium botrys* L.]
Salsola tragus L., 1973 M. Leitzel s.n. Eurasia [*Salsola kali* L. ssp. *tenuifolia* Moq.]

Cistaceae

Helianthemum bicknellii Fern., 1917 B.H. Patterson s.n. G5:S2
Lechea pulchella Raf. var. *pulchella,* 1921 O.E. Jennings s.n.
Lechea racemulosa Michx., 1936 J.A. Churchill s.n.

Clethraceae

Clethra alnifolia L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14321

Clusiaceae

Hypericum ascyron L., 1917 H.J. Osborne s.n. [*Hypericum pyramidatum* Ait.]
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, 1917 B.H. Patterson s.n. G5:SX
Hypericum gentianoides (L.) B.S.P., 1955 W.E. Buker s.n.
Hypericum ellipticum Hook., 1945 W.E. Buker s.n.
Hypericum mutilum L., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14100
Hypericum perforatum L., 2002 H. George s.n. Europe
Hypericum prolificum L., 2002 S.P. Grund and M.L. Speedy 2893
Hypericum punctatum Lam., 1998 K. McGowan and M. Scanlon 378
Hypericum sphaerocarpum Michx., 1921 J. Bright s.n.
Triadenum fraseri (Spach) Gleason, 1900 J.A. Shafer 42

Commelinaceae

Commelina communis L., 2001 S.N. Costabile 19 Asia
Tradescantia ohiensis Raf., 1946 W.E. Buker s.n. G5:S4
Tradescantia virginiana L., 1964 N.R. Farnsworth WP-757

Convolvulaceae

Convolvulus arvensis L., 1997 S.A. Thompson and B.L. Isaac 13644 Europe

Calystegia hederacea Wallich, 1918 J. Bright s.n. Japan [*Calystegia pellita* (Ledeb.) G. Don]

Calystegia sepium (L.) R. Br. ssp. *americana* (Sims) Brummit, 1952 W.E. Buker s.n.

Calystegia sepium (L.) R. Br. ssp. *angulata* Brummitt, 1990 W.A. Zanol 329

Calystegia sepium (L.) R. Br. ssp. *erratica* Brummitt, 1944 L.K. Henry s.n.

Calystegia silvatica (Kit.) Griseb. ssp. *fraterniflora* (Mackenzie & Bush) Brummitt, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15092

Calystegia spithamaea (L.) Pursh ssp. *spithamaea*, 1937 O.E. Jennings s.n.

Ipomoea hederacea Jacq., 1927 J. Bright s.n.

Ipomoea pandurata (L.) G.F.W. Mey., 1954 O.E. Jennings s.n.

Ipomoea purpurea (L.) Roth, 1990 W.A. Zanol 260 Tropical America

Cornaceae

Cornus alternifolia L. f., 2001 S.N. Costabile 28

Cornus amomum P. Mill., 2004 C. Tracey and T. Witsell 2004-0027

Cornus florida L., 1998 K. McGowan and B.L. Isaac and M. Scanlon 35

Cornus obliqua Raf., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15129

Cornus racemosa Lam., 1997 B.L. Isaac and M.A. Rosenberger 10168

Nyssa biflora Walt., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13591 [*Nyssa sylvatica* Marsh. var. *biflora* (Walt.) Sarg.]

Nyssa sylvatica Marsh., 1986 S.A. Thompson 3339

Crassulaceae

Hylotelephium spectabile (Boreau) H. Ohba., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15177 Japan [*Sedum spectabile* Boreau]

Hylotelephium telephium (L.) H. Ohba. ssp. *telephium*, 1940 L.K. Henry s.n. Eurasia [*Sedum telephium* L.]

Penthorum sedoides L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15167

Sedum acre L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13590 Eurasia

Sedum sarmentosum Bunge, 1997 S.A. Thompson and B.L. Isaac and M. Sally 13484 China

Sedum ternatum Michx., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14353

Cucurbitaceae

Cucurbita pepo L. var. *pepo*, 1915 O.E. Jennings s.n. Exotic

Echinocystis lobata (Michx.) Torr. & A. Gray, 1994 W.A. Zanol 3468

Sicyos angulatus L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15138

Cuscutaceae

Cuscuta coryli Engelm., 1897 J.A. Shafer s.n. G5:SU

Cuscuta gronovii Willd. ex J.A. Shultes var. *gronovii*, 1998 K. McGowan and M. Scanlon 345

Cuscuta pentagona Engelm. var. *pentagona*, 1968 W.E. Buker s.n. G5:S3

Cyperaceae

Bulbostylis capillaris (L.) Kunth ex C.B. Clarke ssp. *capillaris*, 1982 W.W. Thomas and W.E. Buker 2976

Carex aggregata Mackenzie, 1997 B.L. Isaac and J.A. Isaac 9599 [*Carex sparganioides* Muhl.ex Willd. var. *aggregata* (Mackenzie) Gleason]

Carex albicans Willd. ex Spreng var. *albicans*, 1977 J. Marin s.n. [*Carex artitecta* Mackenzie]

Carex albolutescens Schwein., 1991 W.A. Zanol 582

Carex albursina Sheldon, 1969 W.E. Buker s.n.

Carex amphibola Steud., 1946 W.E. Buker s.n.

Carex annectens (Bickn.) Bickn., 1997 S.A. Thompson and B.L. Isaac 13849

Carex appalachica J. Webber & P.W. Ball, 2002 B.L. Isaac and J.A. Isaac 14338

Carex atlantica Bailey ssp. *atlantica*, 1900 J.A. Shafer s.n.

Carex baileyi Britt., 1924 H.W. Graham and W. Schiller s.n.

Carex blanda Dewey, 1997 B.L. Isaac and J.A. Isaac 9598

Carex bromoides Schkuhr ex Willd. ssp. *bromoides*, 1945 O.E. Jennings s.n.

Carex bushii Mackenzie, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13587

Carex buxbaumii Wahlenb., 1890 B.H. Patterson s.n. G5:S3

Carex careyana Torr. ex Dewey, 1875 S.W. Knipe s.n. G4G5:S1

Carex caroliniana Schwein, 1922 J. Bright s.n.

Carex cephaloidea (Dewey) Dewey, 1991 J.A. Isaac 3644

Carex cephalophora Muhl. ex Willd., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13577

Carex communis Bailey var. *communis*, 1941 O.E. Jennings s.n.

Carex conjuncta Boott, 1924 J. Bright s.n. G4G5:S4

Carex crinita Lam. var. *crinita*, 1945 L.K. Henry s.n.

Carex cristatella Britt., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2275

Carex debilis Michx. var. *rudgei* Bailey, 1893 B.H. Patterson s.n.

Carex digitalis Willd. var. *digitalis*, 2002 B.L. Isaac and J.A. Isaac 14342

Carex emoryi Dewey, 1926 J. Bright s.n.

Carex festucacea Schkuhr ex Willd., 1922 J. Bright s.n.

Carex frankii Kunth, 2003 C.M. Bowers s.n.

Carex glaucodea Tuckerman ex Olney, 1923 J. Bright s.n.

Carex gracilescens Steud., 1926 J. Bright s.n.

Carex gracillima Schwein., 1924 H.W. Graham and W. Schiller s.n.

Carex granularis Muhl. ex Willd., 1991 W.A. Zanol 801

Carex grayi Carey, 1922 J. Bright s.n.

Carex grisea Wahlenb., 1998 S.A. Thompson and M. Burroughs 14405

Carex gynandra Schwein., 1982 W.E. Buker s.n.

Carex hirsutella Mackenzie, 1996 L.L. Smith and R. Hawk 48

Carex hirtifolia Mackenzie, 1919 J. Bright s.n.

Carex hitchcockiana Dewey, 1924 J. Bright s.n.

Carex hystericina Muhl. ex Willd., 1982 W.E. Buker s.n.

Carex jamesii Schwein., 1925 J. Bright s.n.

Carex laevivaginata (Kukenth.) Mackenzie, 2004 C. Tracey 2004-0002

Carex laxiculmis Schwein. var. *copulata* (Bailey) Fern., 1925 J. Bright s.n. [*Carex x copulata* (Bailey) Mackenzie]

Carex laxiculmis Schwein. var. *laxiculmis*, 1921 O.E. Jennings s.n.

Carex laxiflora Lam., 1992 W.A. Zanol 985

Carex leptonervia (Fern.) Fern., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13586

Carex lucorum Willd. ex Link var. *lucorum*, 1907 O.E. Jennings s.n. [*Carex pensylvanica* Lam. var. *distans* Peck]

Carex lupulina Muhl. ex Willd., 1922 J. Bright s.n.

Carex lurida Wahlenb., 1991 W.A. Zanol 827

Carex mesochorea Mackenzie, 2002 B.L. Isaac and J.A. Isaac 14336 [*Carex cephalophora* Muhl. ex Willd. var. *mesochorea* (Mackenzie) Gleason]

Carex molesta Mackenzie ex Bright, 1936 J.A. Churchill s.n.

Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott, 1925 J. Bright s.n.

Carex normalis Mackenzie, 1998 S.A. Thompson and M. Burroughs 14401

Carex oligocarpa Schkuhr ex Willd., 1924 J. Bright s.n.

Carex pensylvanica Lam., 1997 B.L. Isaac and J.A. Isaac 9596

Carex plantaginea Lam., 1916 J. Bright s.n.

Carex platyphylla Carey, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14349

Carex prasina Wahlenb., 1926 J. Bright s.n.

Carex projecta Mackenzie, 1908 O.E. Jennings s.n.

Carex radiata (Wahlenb.) Small, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13578

Carex retroflexa Muhl. ex Willd., 1921 O.E. Jennings s.n.

Carex rosea Schkuhr ex Willd., 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14355

Carex scabrata Schwein, 1997 L.L. Smith 92

Carex scoparia Schkuhr ex Willd. var. *scoparia*, 2003 C.M. Bowers s.n.

Carex shortiana Dewey, 1945 O.E. Jennings s.n. G5:S3

Carex sparganioides Muhl. ex Willd., 1980 D.E. Boufford and E.W. Wood 22159

Carex spicata Huds., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13588 Europe

Carex squarrosa L., 1922 J. Bright s.n.

Carex stipata Muhl. ex Willd. var. *stipata*, 1991 W.A. Zanol 563

Carex swanii (Fern.) Mackenzie, 1982 S.A. Thompson and W.E. Buker 464

Carex tonsa (Fern.) Bickn. var. *rugosperma* (Mackenzie) Crins, 1922 J. Bright s.n.

Carex torta Boott ex Tuckerman, 1991 W.A. Zanol 555

Carex tribuloides Wahlenb. var. *tribuloides*, 1945 L.K. Henry s.n.

Carex typhina Michx., 1925 J. Bright s.n. G5:S2

Carex umbellata Schkuhr ex Willd., 1920 O.E. Jennings s.n. [*Carex abdita* Bickn.]

Carex virescens Muhl. ex Willd., 1923 J. Bright s.n.

Carex vulpinoidea Michx., 2003 C.M. Bowers s.n.

Cyperus bipartitus Torr., 1935 C.M. Boardman s.n.

Cyperus echinatus (L.) Wood, 1925 J. Bright s.n. [*Cyperus ovularis* (Michx.) Torr.]

Cyperus erythrorhizos Muhl., 1891 T. Seal s.n.

Cyperus esculentus L. var. *leptostachyus* Boeckl., 2004 C. Tracey and S. Miller 2004-0024

Cyperus lupulinus (Spreng.) Marcks ssp. *lupulinus*, 1979 D.E. Boufford and E.W. Wood and W.E. Buker 21122 [*Cyperus filiculmis* auct. Non Vahl]

Cyperus lupulinus (Spreng.) Marcks ssp. *macilentus* (Fern.) Marcks, 1902 J.A. Shafer s.n.

Cyperus strigosus L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15168

Eleocharis acicularis (L.) Roemer & J.A. Schultes var. *acicularis*, 1975 J.M. Eggers 12

Eleocharis obtusa (Willd.) J.A. Schultes, 2003 C.M. Bowers s.n. G5TNR:S1

Eleocharis palustris (L.) Roemer & J.A. Schultes, 1992 W.A. Zanol 1169

Eleocharis tenuis (Willd.) J.A. Schultes var. *tenuis*, 1879 J.D. Shafer s.n.

Eriophorum virginicum L., 1948 L.K. Henry s.n.

Fimbristylis autumnalis (L.) Roemer & J.A. Schultes, 1891 J.D. Shafer s.n.

Kyllinga pumila Michx., 1891 T. Seal s.n. [*Cyperus tenuifolius* (Steud.) Dandy]

Schoenoplectus acutus (Muhl. Ex Bigelow) A. & D. Love var. *acutus*, 1940 O.E. Jennings s.n. G5:S2 [*Scirpus acutus* Muhl. ex Bigelow var. *acutus*]

Schoenoplectus pungens (Vahl) Palla var. *pungens*, 1940 O.E. Jennings s.n.

Schoenoplectus tabernaemontani (K.C. Gmel.) Palla, 1944 O.E. Jennings s.n. [*Scirpus validus* Vahl. var. *creber* Fern.]

Scirpus atrovirens Willd., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2273

Scirpus cyperinus (L.) Kunth, 1993 L.L. Smith s.n.

Scirpus hattorianus Makino, 1982 W.E. Buker s.n.

Scirpus georgianus Harper, 1997 S.A. Thompson and B.L. Isaac 13851 [*Scirpus atrovirens* Willd. var. *georgianus* (Harper) Fern.]

Scirpus pendulus Muhl., 1992 W.A. Zanol 1220

Scirpus polyphyllus Vahl, 1998 K. McGowan and M. Scanlon 311

Trichophorum planifolium (Spreng.) Palla, 1946 W.E. Buker s.n. [*Scirpus verecundus* Fern.]

Dioscoreaceae

Dioscorea polystachya Turcz., 1929 O.E. Jennings s.n. Eastern Asia [*Dioscorea oppositifolia* L.]

Dioscorea villosa L., 1992 W.A. Zanol 1174

Dipsacaceae

Dipsacus fullonum L., 1997 S.A. Thompson and B.L. Isaac 13853 Europe [*Dipsacus sylvestris* Huds.]

Ebenaceae

Diospyros virginiana L., 1934 H.M. McCracken s.n.

Elaeagnaceae

Elaeagnus umbellata Thunb., 1998 K. McGowan and M. Scanlon 119 Asia

Ericaceae

Epigaea repens L., 1991 W.A. Zanol 512

Gaultheria procumbens L., 1932 C.M. Hepner s.n.

Gaylussacia baccata (Wangenh.) K. Koch, 1945 L.K. Henry s.n.

Kalmia latifolia L., 1992 W.A. Zanol 1121

Lyonia ligustrina (L.) DC. var. *ligustrina*, 1900 J.A. Shafer s.n.

Oxydendrum arboreum (L.) DC., 1915 O.E. Jennings s.n. G5:S3S4

Rhododendron arborescens (Pursh.) Torr., 1894 A. Koenig s.n.

Rhododendron maximum L., 1988 S. Miller 3

Rhododendron periclymenoides (Michx.) Shinners, 1926 H.W. Graham s.n.

Rhododendron prinophyllum (Small) Millais, 1945 L.K. Henry s.n.

Vaccinium angustifolium Aiton, 1945 L.K. Henry s.n.

Vaccinium corymbosum L., 1991 W.A. Zanol 494

Vaccinium pallidum Ait., 2002 S.P. Grund and M.L. Speedy 2895

Vaccinium stamineum L., 1992 W.A. Zanol 1154

Euphorbiaceae

Acalypha deamii (Weatherby) Ahles, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15126 G4?:SX [*Acalypha rhomboidea* Raf. var. *deamii* (Weatherby) Weatherby]

Acalypha rhomboidea Raf., 1997 S.A. Thompson and B.L. Isaac 14129

Acalypha virginica L., 1923 J. Bright s.n.

Chamaesyce maculata (L.) Small, 1997 S.A. Thompson and B.L. Isaac 14178 [*Euphorbia maculata* L.]

Chamaesyce nutans (Lag.) Small, 1997 S.A. Thompson and B.L. Isaac 14128 [*Euphorbia nutans* Lag.]

Chamaesyce vermiculata (Raf.) House, 1953 L.K. Henry and D.E. Long s.n. [*Euphorbia vermiculata* Raf.]

Euphorbia commutata Engelm. ex A. Gray, 1960 E.J. Mason s.n.

Euphorbia corollata L., 2000 R.B. Coxe s.n.

Euphorbia cyparissias L., 1981 H.J. Kendall Jr. s.n. Eurasia

Euphorbia dentata Michx. var. *dentata*, 1997 S.A. Thompson and B.L. Isaac 14180

Euphorbia marginata Pursh, 1998 B.L. Isaac and J.A. Isaac 11758

Euphorbia platyphyllos L., 1900 J.A. Shafer s.n. Europe

Fabaceae

Amorpha fruticosa L., 1998 J.A. Bower s.n.

Amphicarpaea bracteata (L.) Fern. var. *comosa* (L.) Fern., 1991 W.A. Zanol 904

Apios americana Medik., 1990 W.A. Zanol 195 [*Apios americana* Medik. var. *turrigera* Fern.]

Astragalus canadensis L. var. *canadensis*, 1945 W.E. Buker s.n. G5:S2

Baptisia australis (L.) R. Br. ex Ait. f. var. *australis*, 1946 R. Vinski s.n. G5:S3

Baptisia tinctoria (L.) R. Br. ex Ait. f., 1934 J. Churchill s.n.

Ceratonia siliqua L., 1994 S.A. Thompson 11720 Exotic

Cercis canadensis L. var. *canadensis*, 1997 S.A. Thompson and B.L. Isaac 14145

Chamaecrista fasciculata (Michx.) Greene var. *fasciculata*, 1950 C.J. Poth s.n.

Chamaecrista nictitans (L.) Moench ssp. *nictitans* var. *nictitans*, 1993 W.A. Zanol 2067

Codariocalyx gyroides (Roxb. ex Link) Hassk., 1902 J.A. Shafer s.n. [*Desmodium ciliare* (Muhl. ex Willd.) DC.]

Colutea arborescens L., 2002 B.L. Isaac and J.A. Isaac 14538 Mediterranean

Desmodium canadense (L.) DC., 1990 W.A. Zanol 314

Desmodium canescens (L.) DC., 1963 N.R. Farnsworth WP-468

Desmodium cuspidatum (Muhl. Ex Willd.) DC ex Loud. var. *cuspidatum*, 1998 K. McGowan and M. Scanlon 249

Desmodium glabellum (Michx.) DC., 1909 O.E. Jennings s.n. G5:SU

Desmodium glutinosum (Muhl. ex Willd.) Wood, 1948 W.E. Buker s.n.

Desmodium humifusum (Muhl. Ex Bigelow) Beck, 1899 J.A. Shafer s.n.

Desmodium nudiflorum (L.) DC., 1921 O.E. Jennings s.n.

Desmodium paniculatum (L.) DC., 1990 W.A. Zanol 390

Desmodium perplexum Schub., 1998 K. McGowan and M. Scanlon 366 [*Desmodium dillenii* Darl.]

Desmodium rotundifolium DC., 1953 W.E. Buker s.n.

Gleditsia triacanthos L., 1998 B.L. Isaac and J.A. Isaac 11641

Lespedeza capitata Michx., 1947 E. Mason s.n. [*Lespedeza capitata* Michx. var. *vulgaris* Torr. & A. Gray]

Lathyrus latifolius L., 2001 S.N. Costabile 7 Europe

Lathyrus tuberosus L., 1917 H.J. Osborne s.n. Europe and West Asia

Lespedeza frutescens (L.) Hornem., 1968 Segalman and H. Fong WP-1430 [*Lespedeza intermedia* (S. Wats.) Britt.]

Lespedeza hirta (L.) Hornem. ssp. *hirta*, 1932 C.M. Hepner s.n.

Lespedeza procumbens Michx., 1991 W.A. Zanol 883

Lespedeza repens (L.) W. Bart, 1955 W.E. Buker s.n.

Lespedeza violacea (L.) Pers., 1949 W.E. Buker s.n.

Lespedeza virginica (L.) Britt., 1955 W.E. Buker s.n.

Lotus corniculatus L., 1990 W.A. Zanol 127 Europe

Medicago lupulina L., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13467 Eurasia

Medicago sativa L. ssp. *sativa*, 1994 W.A. Zanol 2869 Eurasia

Melilotus officinalis (L.) Lam., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13470 Eurasia [*Melilotus albus* Medik.]

Phaseolus coccineus L., 1994 S.A. Thompson 11722 Tropical America

Pisum sativum L., 1918 O.E. Jennings s.n. Eurasia

Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida, 2001 J.A. Isaac 13625 Eastern Asia [*Pueraria lobata* (Willd.) Ohwi]

Robinia hispida L. var. *hispida*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14313

Robinia pseudoacacia L., 2002 B.L. Isaac and J.A. Isaac 14378

Securigera varia (L.) Lassen, 2001 S.N. Costabile 5 Southern Europe [*Coronilla varia* L.]

Senna hebecarpa (Fern.) Irwin & Barneby, 1998 B.L. Isaac and J.A. Isaac 11741

Senna marilandica (L.) Link, 1916 F.R. Alker s.n. G5:S1

Strophostyles helvola (L.) Ell., 1953 C.J. Poth s.n.

Tephrosia virginiana (L.) Pers., 1912 J. Bright s.n.

Trifolium arvense L., 1901 J.E. Winner s.n. Eurasia
Trifolium aureum Pollich, 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2279 Eurasia
Trifolium campestre Schreb., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13584 Europe
Trifolium dubium Sibthorp, 1962 C.J. Poth s.n. Europe
Trifolium hybridum L., 2001 S.N. Costabile 3 Eurasia
Trifolium incarnatum L., 1949 L.K. Henry s.n. Europe
Trifolium pratense L., 2003 C. Tracey 2003-0014 Europe
Trifolium reflexum L., 1886 J.A. Shafer s.n. G3G4:SX
Trifolium repens L., 1998 K. McGowan and M. Scanlon 168 Europe
Vicia americana Muhl. ex Willd. ssp. *americana*, 1897 A. Koenig s.n.
Vicia caroliniana Walt., 1946 W.E. Buker s.n.
Vicia sativa L. ssp. *sativa*, 1923 J. Bright s.n. Europe
Vicia villosa Roth ssp. *villosa*, 1944 L.K. Henry s.n. Europe
Vigna angularis (Willd.) Ohwi & Ohashi, 1994 S.A. Thompson 11723

Fagaceae

Castanea dentata (Marsh.) Borkh., 1977 H. Shockey s.n.
Castanea mollissima Blume, 1991 W.A. Zanol 496 Asia
Castanea pumila (L.) P. Mill var. *pumila*, 1920 C.W. Parker s.n.
Fagus grandifolia Ehrh., 1969 F.B. Schell s.n.
Quercus alba L., 1998 S.A. Thompson and B.L. Isaac 14978
Quercus bicolor Willd., 2002 B.L. Isaac and J.A. Isaac 14349
Quercus coccinea Muenchh., 1998 B.L. Isaac and J.A. Isaac 11671
Quercus ilicifolia Wangenh., 1932 C.M. Hepner s.n.
Quercus imbricaria Michx., 1998 S.A. Thompson and B.L. Isaac 14965
Quercus macrocarpa Michx. var. *macrocarpa*, 2002 B.L. Isaac and J.A. Isaac 14362
Quercus muehlenbergii Engelm., 1941 O.E. Jennings s.n.
Quercus palustris Muenchh., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15142
Quercus prinoides Willd., 1957 J. Grom s.n.
Quercus prinus L., 1964 P.B. Monk s.n.
Quercus rubra L., 1998 S.A. Thompson and B.L. Isaac 14979
Quercus velutina Lam., 1998 B.L. Isaac and J.A. Isaac 11643
Quercus x leana Nutt. (pro sp.), 1934 E.H. Graham s.n.
Quercus x runcinata (A. DC.) Engelm., 1937 H.H. Chisman s.n.

Fumariaceae

Adlumia fungosa (Ait.) Greene ex B.S.P., 1945 W.E. Buker s.n.
Capnoides sempervirens (L.) Borkh., 1900 J.A. Shafer s.n. [*Corydalis sempervirens* (L.) Pers.]
Corydalis flavula (Raf.) DC., 1998 K. McGowan and M. Scanlon 12
Dicentra canadensis (Goldie) Walp., 1937 C.M. Boardman s.n.
Dicentra cucullaria (L.) Bernh., 1999 B.L. Isaac and T. Herman 11774
Fumaria officinalis L. ssp. *officinalis*, 1996 A.W. Cusick 33095 Eurasia

Gentianaceae

Bartonia virginica L. (B.S.P.), 1899 J.A. Shafer s.n.
Gentiana andrewsii Griseb. var. *andrewsii*,1940 H.H. Wolfe s.n.
Gentiana clausa Raf., 1932 O.E. Jennings s.n.
Gentianopsis crinita (Froel.) Ma, 1886 J.D. Shafer s.n.
Obolaria virginica L., 1891 B.H. Patterson s.n.
Sabatia angularis (L.) Pursh, 1945 W.E. Buker s.n.

Geraniaceae

Erodium cicutarium (L.) L'Her. ex Ait., 1992 S.A. Thompson 10042 Europe
Geranium carolinianum L. var. *carolinianum*, 1998 S.A. Thompson and M. Burroughs 14408
Geranium maculatum L., 1998 K. McGowan and M. Scanlon 125
Geranium pusillum L., 1992 A.W. Cusick 30374 Europe
Geranium robertianum L. ssp. *robertianum*, 1992 W.A. Zanol 1157
Geranium sanguineum L., 2002 B.L. Isaac and J.A. Isaac 14334 Eurasia
Geranium thunbergii Sieb. & Zucc. ex Lindl. & Paxton, 1963 W.E. Buker s.n. Eastern Asia

Grossulariaceae

Ribes americanum P.Mill., 1998 S.A. Thompson and B.L. Isaac 14955
Ribes cynosbati L., 1945 L.K. Henry s.n.
Ribes rotundifolium Michx., 1942 R.L. Fricke s.n.
Ribes rubrum L., 1928 J. Bright s.n. Eurasia [*Ribes sativum* Syme]

Haloragaceae

Myriophyllum sibiricum Komarov, 2002 M.L. Young and B.R. Swiech 1 G5:S1

Hamamelidaceae

Hamamelis virginiana L., 1998 K. McGowan and M. Scanlon 10
Liquidambar styraciflua L., 1935 L.F. Allabach s.n.

Hippocastanaceae

Aesculus flava Ait., 1960 E.J. Mason s.n.
Aesculus glabra Willd. var. *glabra*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13568
Aesculus hippocastanum L., 1991 G.H. Pollack 48 Eurasia

Hydrangeaceae

Hydrangea arborescens L., 2002 B.L. Isaac and J.A. Isaac 14382
Philadelphus coronarius L., 1997 S.A. Thompson and B.L. Isaac 14257 Eurasia

Hydrocharitaceae

Elodea canadensis Michx., 1991 B.L. Isaac and J.A. Isaac and E. Allen 3509
Elodea nuttallii (Planch.) St. John, 1933 W.R. Van Dersal s.n.
Vallisneria americana Michx., 1899 J.A. Shafer s.n.

Hydrophyllaceae

Hydrophyllum appendiculatum Michx., 1997 B.L. Isaac and J.A. Isaac 9618
Hydrophyllum canadense L., 1992 W.A. Zanol 1237
Hydrophyllum virginianum L. var. *virginianum*, 2002 B.L. Isaac and J.A. Isaac 14365
Phacelia purshii Buckl., 1937 L.K. Henry s.n.

Iridaceae

Iris cristata Ait., 1923 J. Bright s.n. G5:S1
Iris pseudacorus L., 1991 W.A. Zanol 579 Europe
Iris versicolor L., 1992 W.A. Zanol 1152
Sisyrinchium albidum Raf., 1918 W.H. Emig s.n. G5?:SH
Sisyrinchium angustifolium P. Mill., 1997 S.A. Thompson and B.L. Isaac 13847
Sisyrinchium atlanticum Bickn., 1979 D.E. Boufford and E.W. Wood and N. Foust 21192 G5:S1
Sisyrinchium mucronatum Michx., 1946 W.E. Buker s.n.

Juglandaceae

Carya alba (L.) Nutt ex Ell., 1991 W.A. Zanol 856 [*Carya tomentosa* (Lam. Ex Poir.) Nutt]
Carya cordiformis (Wangenh.) K. Koch, 1998 S.A. Thompson and B.L. Isaac 14972
Carya glabra (P. Mill) Sweet, 1998 S.A. Thompson and B.L. Isaac 14971
Carya ovata (P. Mill) K. Koch, 1947 E. Mason s.n.
Juglans cinerea L., 1944 L.K. Henry s.n.
Juglans nigra L., 2002 M.L. Young and B.R. Swiech 4

Juncaceae

Juncus acuminatus Michx., 1921 O.E. Jennings s.n.
Juncus bufonius L., 1975 J.M. Eggers 18
Juncus canadensis J. Gay ex Laharpe, 1993 L.L. Smith s.n.
Juncus dichotomus Ell., 1908 O.E. Jennings s.n. G5:S1
Juncus dudleyi Wieg., 2003 C.M. Bowers s.n.
Juncus effusus L. ssp. *solutus* (Fern. & Wieg.) Hamet-Ahti, 2004 C. Tracey and S. Miller 2004-0006
Juncus gerardii Loisel var. *gerardii*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14312
Juncus marginatus Rostk., 1907 O.E. Jennings and G.K. Jennings s.n.
Juncus secundus Beauv. ex Poir, 1899 J.A. Shafer s.n.
Juncus subcaudatus (Engelm.) Coville & Blake var. *subcaudatus*, 1993 L.L. Smith s.n.
Juncus torreyi Coville, 1887 B.H. Patterson s.n. G5:S2
Juncus tenuis Willd., 2004 C. Tracey 2004-0004
Luzula echinata (Small) F.J. Herm., 1920 O.E. Jennings and G.K. Jennings s.n.
Luzula multiflora (Ehrh.) Lej., ssp. *multiflora* var. *multiflora*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14359

Lamiaceae

Agastache nepetoides (L.) Kuntze, 1994 W.A. Zanol 3764
Agastache scrophulariifolia (Willd.) Kuntze, 1946 W.E. Buker s.n. [*Agastache scrophulariifolia* (Willd.) Kuntze var. *mollis* (Fern.) Heller]
Ajuga reptans L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14299 Eurasia
Blephilia ciliata (L.) Benth., 1945 W.E. Buker s.n.
Blephilia hirsuta (Pursh) Benth. var. *hirsuta*, 1985 M. Macdonald and K. Stewart LSCW157
Stachys palustris L., 1973 W.E. Buker s.n. Europe
Clinopodium vulgare L., 1998 K. McGowan and M. Scanlon 318 [*Satureja vulgaris* (L.) Fritsch]
Collinsonia canadensis L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15200
Cunila origanoides (L.) Britton, 1898 J.A. Shafer s.n.
Glechoma hederacea L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13564 Eurasia
Hedeoma pulegioides (L.) Pers., 1998 S.A. Thompson and B.L. Isaac 14931
Lamium amplexicaule L., 1964 N.R. Farnsworth WP-708 Eurasia
Lamium maculatum L., 1951 W. Smith s.n. Eurasia
Lamium purpureum L. var. *purpureum*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13600 Eurasia
Leonurus cardiaca L. ssp. *cardiaca*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13565 Asia
Lycopus americanus Muhl. ex W. Bart., 1996 L.L. Smith and R. Hawk 73
Lycopus uniflorus Michx. var. *uniflorus*, 1996 S. Grund 1678
Lycopus virginicus L., 1998 B.L. Isaac and J.A. Isaac 11661
Marrubium vulgare L., 1921 O.E. Jennings s.n. Eurasia
Meehania cordata (Nutt.) Britt., 1948 E. Mason s.n. G5:S1
Melissa officinalis L., 1920 J. Bright s.n. Asia
Mentha aquatica L., 1913 J. Bright s.n. Eurasia
Mentha arvensis L., 1990 W.A. Zanol 190 [*Mentha gentilis* L.]
Mentha spicata L., 1968 N.R. Farnsworth WP-1585 Europe
Mentha suaveolens Ehrh., 1917 B.H. Patterson s.n. Eurasia [*Mentha rotundifolia* auct. non (L.) Huds.]
Mentha x piperita L. (pro sp.), 1994 W.A. Zanol 3496 Eurasia
Mentha x rotundifolia (L.) Huds. (pro sp.), 1994 W.A. Zanol 3458 Eurasia
Monarda clinopodia L., 1965 N.R. Farnsworth WP-1130
Monarda fistulosa L. ssp. *fistulosa* var. *fistulosa*, 1990 W.A. Zanol 221
Monarda didyma L., 1998 K. McGowan and M. Scanlon 300
Monarda fistulosa L. ssp. *fistulosa* var. *mollis* (L.) Benth., 1925 L.K. Henry s.n.
Monarda media Willd., 1967 N.R. Farnsworth WP-1469
Monarda punctata L. ssp. *punctata* var. *villicaulis* (Pennell) Palmer & Steyermark, 1907 J.A. Shafer s.n. G5:SH
Nepeta cataria L., 1994 W.A. Zanol 3745 Eurasia
Physostegia virginiana (L.) Benth. ssp. *virginiana*, 1923 J. Bright s.n.
Prunella vulgaris L. ssp. *lanceolata* (W. Bart.) Hulten, 1967 N.R. Farnsworth WP-1501
Prunella vulgaris L. ssp. *vulgaris*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13561 Europe
Pycnanthemum incanum (L.) Michx. var. *incanum*, 1969 W.E. Buker s.n.
Pycnanthemum tenuifolium Schrad., 1945 W.E. Buker s.n.
Pycnanthemum verticillatum (Michx.) Pers. var. *verticillatum*, 1945 W.E. Buker s.n.
Pycnanthemum virginianum (L.) T. Dur. & B.D. Jackson ex B.L. Robins. & Fern., 1921 O.E. Jennings s.n.
Salvia reflexa Hornem., 1918 E.M. Gress and A.R. Hillard s.n.
Scutellaria elliptica Muhl. ex Spreng. var. *hirsuta* (Short & Peter) Fern., 1901 J.A. Shafer
Scutellaria galericulata L., 1953 L.K. Henry and D.E. Long s.n.
Scutellaria incana Biehler var. *incana*, 1945 L.K. Henry s.n.
Scutellaria integrifolia L., 1932 C.M. Hepner s.n.
Scutellaria lateriflora L. var. *lateriflora*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13596

Scutellaria nervosa Pursh, 1968 W.E. Buker s.n.

Scutellaria parvula Michx. var. *missouriensis* (Torr.) Goodman & Lawson, 1888 J.A. Shafer 1033 [*Scutellaria leonardii* Epling]

Scutellaria saxatilis Riddell, 1994 L.L. Smith and C.J. Boget 31 G3:S1

Stachys tenuifolia Willd., 1973 G. Wallace s.n.

Teucrium canadense L. var. *canadense*, 1998 S.A. Thompson and B.L. Isaac 14938

Trichostema brachiatum L., 1901 J.A. Shafer 100 [*Isanthus brachiatus* (L.) B.S.P.]

Trichostema dichotomum L., 1996 L.L. Smith and R. Hawk 74

Lardizabalaceae

Akebia quinata (Houtt.) Dcne., 2002 B.L. Isaac and J.A. Isaac 14369 Asia

Lauraceae

Lindera benzoin (L.) Blume, 1998 K. McGowan and B.L. Isaac and M. Scanlon 39

Sassafras albidum (Nutt.) Nees, 1986 S.A. Thompson 3334 [*Sassafras albidum* (Nutt.) Nees var. *molle* (Raf.) Fern.]

Lemnaceae

Lemna minor L., 1953 L.K. Henry and D.E. Long s.n.

Lemna turionifera Landolt, 1947 W.E. Buker s.n. G5:SU

Spirodela polyrrhiza (L.) Schleid., 1925 O.E. Jennings s.n.

Wolffia columbiana Karst., 1931 O.E. Jennings s.n.

Liliaceae

Allium canadense L. var. *canadense*, 1992 W.A. Zanol 1226

Allium cepa L., 1918 O.E. Jennings s.n. Western Asia

Allium cernuum Roth var. *cernuum*, 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2292

Allium sativum L., 1998 K. McGowan and M. Scanlon 206 Central Asia

Allium schoenoprasum L., 1883 J.A. Shafer s.n.

Allium tricoccum Ait., 1946 W.E. Buker s.n.

Allium vineale L. ssp. *vineale*, 1991 W.A. Zanol 816 Europe

Asparagus officinalis L., 1991 W.A. Zanol 585 Europe

Camassia scilloides (Raf.) Cory, 2006 L. Speedy and T. Schumann LS-06-257 G4G5:S1

Chamaelirium luteum (L.) A. Gray, 1980 W.E. Buker s.n.

Clintonia umbellulata (Michx.) Morong, 1982 C. Metelmann s.n.

Erythronium albidum Nutt., 1997 F.H. Utech 97-002 G5:S3

Erythronium americanum Ker-Gawl. ssp. *americanum*, 1991 W.A. Zanol 433

Galanthus elwesii Hook. F., 1984 S.A. Thompson 1326 Turkey

Hemerocallis fulva (L.) L., 2001 S.N. Costabile 9 Asia

Hemerocallis lilioasphodelus L., 1990 W.A. Zanol 121 Europe

Hosta ventricosa (Salisb.) Stearn, 1977 W.E. Buker s.n. Asia

Hyacinthoides non-scripta (L.) Chouard ex Rothm., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14315 Europe [*Scilla nonscripta* (L.) Hoffmgg. & Link]

Hypoxis hirsuta (L.) Coville, 1924 H.W. Graham and W. Schiller s.n.

Lilium canadense L. ssp. *editorum* (Fern.) Wherry, 1977 W.E. Buker s.n.

Lilium superbum L., 1994 W.A. Zanol 3071

Maianthemum canadense Desf., 1932 C.M. Boardman s.n.

Maianthemum racemosum (L.) Link ssp. *racemosum*, 1998 K. McGowan and M. Scanlon 150 [*Smilacina racemosa* (L.) Desf.]

Medeola virginiana L., 1991 W.A. Zanol 576

Muscari botryoides (L.) P. Mill., 1991 W.A. Zanol 430 Europe

Narcissus pseudonarcissus L., 1991 W.A. Zanol 420 Europe

Ornithogalum nutans L., 1945 H. Roslund s.n. Europe

Ornithogalum umbellatum L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14305 Europe

Polygonatum biflorum (Walt.) Ell. var. *commutatum* (J.A. & J.H. Schultes) Morong, 1991 W.A. Zanol 772

Polygonatum pubescens (Willd.) Pursh, 1998 K. McGowan and M. Scanlon 93

Scilla siberica Haw., 1984 M. Macdonald and K. Stewart LSCW 20 Eurasia

Stenanthium gramineum (Ker-Gawl.) Morong, 1945 W.E. Buker s.n. G4G5:S1S2

Trillium cernuum L., 1925 O.E. Jennings and G.K. Jennings s.n. G5:S3

Trillium erectum L., 1991 W.A. Zanol 442

Trillium flexipes Raf., 1972 R. Friday s.n. G5:S2

Trillium grandiflorum (Michx.) Salisb., 1991 W.A. Zanol 473

Trillium nivale Riddell, 1997 S.P. Grund and R. Schultz 1786 G4:S3

Trillium sessile L., 1997 F.H. Utech 97-003

Trillium undulatum Willd., 1965 N.R. Farnsworth WP-1192

Uvularia grandiflora Sm., 1945 L.K. Henry s.n.

Uvularia perfoliata L., 1984 B. Behrer and M. Macdonald LSCW 33

Uvularia sessilifolia L., 1991 W.A. Zanol 488

Veratrum virginicum (L.) Ait. f., 1900 J.A. Shafer s.n. G5:SU [*Melanthium virginicum* L.]

Veratrum viride Aiton var. *viride*, 1991 W.A. Zanol 696

Limnanthaceae

Floerkea proserpinacoides Willd., 1998 K. McGowan and B.L. Isaac and M. Scanlon 72

Linaceae

Linum striatum Walt., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2303

Linum usitatissimum L., 1993 F.H. Utech 93-870 Europe

Linum virginianum L., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger

Lythraceae

Ammannia coccinea Rottb., 1993 W.A. Zanol 2069 G5:S2 [*Ammania coccinea* Rottb. ssp. *purpurea* (Lam.) Koehne]

Cuphea viscosissima Jacq., 1950 D.H. Krouse s.n.

Lythrum alatum Pursh var. *alatum*, 1921 O.E. Jennings s.n. G5:S1

Lythrum salicaria L., 2001 S.N. Costabile 22 Europe

Magnoliaceae

Liriodendron tulipifera L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14339

Magnolia acuminata (L.) L., 1997 F.H. Utech 97-160

Magnolia tripetala (L.) L., 1997 B.L. Isaac and J.A. Isaac 9607 G5:S2

Magnolia virginiana L., 2005 L. Speedy and M. Bowers LSB1285-1 G5:S2

Malvaceae

Abutilon theophrasti Medik., 1990 W.A. Zanol 337 Asia
Alcea rosea L., 1949 D. Benzenhoefer s.n. China
Hibiscus moscheutos L. var. *moscheutos*, 1969 W.E. Buker s.n.
Hibiscus syriacus L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15139 Asia
Hibiscus trionum L., 1991 W.A. Zanol 893 Europe
Malva moschata L., 1994 W.A. Zanol 3075 Europe
Malva neglecta Wallr., 1966 R.N. Blomster WP-818 Eurasia and North Africa
Malva pusilla Sm., 1990 W.A. Zanol 120 Europe [*Malva rotundifolia* L.]
Malva sylvestris L., 1903 J.A. Shafer s.n. Eurasia
Sida spinosa L., 1942 J. Wurdack s.n.

Menispermaceae

Menispermum canadense L., 1997 S.A. Thompson 13442

Molluginaceae

Mollugo verticillata L., 1997 S.A. Thompson and B.L. Isaac 13861

Monotropaceae

Monotropa hypopithys L., 1947 L.K. Henry s.n.
Monotropa uniflora L., 1990 W.A. Zanol 215

Moraceae

Fatoua villosa (Thunb.) Nakai, 1989 S.A. Thompson 6354 Eastern Asia
Ficus carica L., 1998 B.L. Isaac and J.A. Isaac 11739 Mediterranean
Maclura pomifera (Raf.) Schneid., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15140
Morus alba L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13613 Asia
Morus rubra L. var. *rubra*, 1966 P. Monk s.n.

Myricaceae

Comptonia peregrina (L.) Coult., 1929 E.H. Graham s.n.
Morella pensylvanica (Mirbel) Kartesz, 1958 M. Reynolds [*Myrica pensylvanica* Mirbel]

Nyctaginaceae

Mirabilis jalapa L., 1953 W.E. Buker s.n. Tropical America
Mirabilis nyctaginea Michx. MacM., 1998 S.A. Thompson 15170

Nymphaeaceae

Nymphaea odorata L. ssp. *tuberose* (Paine) Wiersma & Hellquist, 1986 D.E.K. s.n.

Oleaceae

Chionanthus virginicus L., 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14350 G5:S3
Fraxinus americana L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13551
Fraxinus nigra Marsh., 1944 O.E. Jennings s.n.
Fraxinus pennsylvanica Marsh., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13611
Forsythia suspensa (Thunb.) Vahl, 1998 B.L. Isaac and M. Rosenberger 10212 China
Ligustrum vulgare L., 2004 C. Tracey and P.J. Gruszka and M.B. Steisslinger 2004-0029 Europe
Syringa vulgaris L., 1965 N.R. Farnsworth WP-1019 Europe

Onagraceae

Chamerion angustifolium (L.) Holub ssp. *circumvagum* (Mosquin) Kartesz, 1932 C.M. Hepner s.n.
Circaea alpina L. ssp. *alpina*, 1923 O.E. Jennings s.n.
Circaea canadensis sensu Fern., 2001 S.N. Costabile 10 [*Circaea lutetiana* L. ssp. *canadensis* (L.) Aschers. & Magnus]
Epilobium ciliatum Raf. ssp. *ciliatum*, 1998 A.W. Cusick 34525
Epilobium coloratum Biehler, 2000 R.B. Coxe s.n.
Gaura biennis L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15149
Ludwigia alternifolia L., 1991 W.A. Zanol 905
Ludwigia palustris (L.) Ell., 1940 O.E. Jennings s.n.
Ludwigia peploides (Kunth) Raven ssp. *glabrescens* (Kuntze) Raven, 1991 B.L. Isaac and J.A. Isaac and E. Allen 3510
Oenothera biennis L., 2002 H. George s.n.
Oenothera fruticosa L. ssp. *fruticosa*, 1902 J.A. Shafer s.n.
Oenothera fruticosa L. ssp. *glauca* (Michx.) Straley, 1991 W.A. Zanol 786
Oenothera laciniata Hill, 1895 B.H. Patterson s.n.
Oenothera nutans Atkinson & Bartlett, 1922 O.E. Jennings s.n.
Oenothera parviflora L., 1902 O. Hatry s.n.
Oenothera perennis L., 1997 S.A. Thompson and B.L. Isaac 13840
Oenothera pilosella Raf. ssp. *pilosella*, 1918 O.E. Jennings s.n.
Oenothera speciosa Nutt., 1918 Smith s.n.

Orchidaceae

Aplectrum hyemale (Muhl. ex Willd.) Torr., 1887 J.A. Shafer s.n. G5:S3
Corallorhiza maculata (Raf.) Raf. var. *maculata*, 1978 W.E. Buker s.n.
Corallorhiza maculata Raf. var. *occidentalis* (Lindl.) Ames, 1995 J.S. Shriver and A. Shriver and C. Smith 392
Corallorhiza odontorhiza (Willd.) Poir. var. *odontorhiza*, 1890 J.A. Shafer s.n.
Cypripedium acaule Ait., 1993 J.S. Shriver 33
Cypripedium parviflorum Salisb. var. *pubescens* (Willd.) Knight, 1904 A.D. Frost s.n. [*Cypripedium pubescens* Willd.]
Corallorhiza wisteriana Conrad, 1900 U.G. Sanger s.n. G5:S1
Epipactis helleborine (L.) Crantz, 1998 B.L. Isaac and J.A. Isaac 11726 Europe
Galearis spectabilis (L.) Raf., 1884 J.A. Schaeffer s.n.
Goodyera pubescens (Willd.) R. Br. ex Ait.f., 1997 J.S. Shriver and A. Shriver and C. Smith 811
Isotria verticillata Raf., 1948 C. Shoemaker s.n.
Liparis liliifolia (L.) L.C. Rich. ex Ker-Gawl, 1993 J.S. Shriver 39
Liparis loeselii (L.) L.C. Rich., 1995 J.S. Shriver 391
Platanthera flava (L.) Lindl. var. *herbiola* (R. Br. Ex Ait. F.) Luer, 1993 J.S. Shriver 56
Platanthera lacera (Michx.) G. Don, 1994 J.S. Shriver 252
Platanthera orbiculata (Pursh) Lindl., 1887 J.A. Shafer 978
Platanthera peramoena (A. Gray) A. Gray, 1898 J.A. Shafer s.n. G5:S2

Platanthera psycodes (L.) Lindl., 1912 J. Bright s.n.

Spiranthes cernua (L.) L.C. Rich., 1905 O.E. Jennings s.n.

Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigelow) Luer, 1936 O.E. Jennings s.n.

Spiranthes lucida (H.H. Eaton) Ames, 1997 J.S. Shriver 878 G5:S3

Spiranthes ochroleuca (Rydb.) Rydb., 1939 O.E. Jennings s.n. [*Spiranthes cernua* (L.) L.C. Rich. var. *ochroleuca* (Rydb.) Ames]

Orobanchaceae

Conopholis americana (L.) Wallr. f., 1997 F.H. Utech 97-153

Epifagus virginiana (L.) W. Bart, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14347

Orobanche uniflora L., 1971 W.E. Buker s.n.

Oxalidaceae

Oxalis corniculata L., 1994 A.W. Cusick 31796

Oxalis dillenii Jacq., 1998 S.A. Thompson and M. Burroughs 14399

Oxalis grandis Small, 1992 W.A. Zanol 1103

Oxalis montana Raf., 1992 W.A. Zanol 984 [*Oxalis acetosella* auct. non L.]

Oxalis stricta L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13569

Oxalis violacea L., 1991 W.A. Zanol 542

Papaveraceae

Chelidonium majus L. var. *majus*, 1998 S.A. Thompson and M. Burroughs 14409 Eurasia

Macleaya cordata (Willd.) R. Br., 2002 B.L. Isaac and H. George 14540 Eastern Asia

Papaver rhoeas L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13603 Eurasia and North Africa

Sanguinaria canadensis L., 2002 B.L. Isaac and J.A. Isaac 14381

Passifloraceae

Passiflora lutea L., 1998 B.L. Isaac and J.A. Isaac 11727 G5:S1

Pedaliaceae

Proboscidea louisianica (P. Mill.) Thellung ssp. *louisianica*, 1935 M.B. Knauz s.n.

Phytolaccaceae

Phytolacca americana L. var. *americana*, 1998 S.A. Thompson and B.L. Isaac 14964

Plantanginaceae

Plantago aristata Michx., 1946 H.N. Mozingo s.n.

Plantago lanceolata L., 1997 S.A. Thompson and B.L. Isaac 13860 Europe

Plantago major L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15131

Plantago psyllium L., 1934 W.R. Witz s.n. Mediterranean [*Plantago arenaria* Waldst. & Kit.]

Plantago rugelii Dcne., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2301

Plantago virginica L., 1977 W.E. Buker s.n.

Platanaceae

Platanus occidentalis L., 1997 S.A. Thompson and B.L. Isaac 14200

Platanus x hybrida Brot., 1967 P. Monk s.n. Exotic [*Platanus acerifolia* (Ait.) Willd.]

Poaceae

Agrostis capillaris L., 1947 H. Roslund s.n. Europe [*Agrostis tenuis* Sibthorp]

Agrostis gigantea Roth, 2003 C.M. Bowers s.n. Europe

Agrostis hyemalis (Walt.) B.S.P., 1924 H.W. Graham and W. Schuller s.n.

Agrostis perennans (Walt.) Tuckerman, 1998 B.L. Isaac and J.A. Isaac 11656 G4:SX [*Agrostis altissima* (Walt.) Tuckerman]

Agrostis scabra Willd., 1998 K. McGowan and M. Scanlon 226

Alopecurus aequalis Sobol. var. *aequalis*, 1919 J. Jones s.n. G5:S3

Andropogon gerardii Vitman, 1922 J. Bright s.n. [*Andropogon gerardii* Vitman var. *chrysocomus* (Nash) Fern.]

Andropogon virginicus L. var. *virginicus*, 1998 B.L. Isaac and J.A. Isaac 11655

Anthoxanthum hirtum (Schrank) Y. Schouten & Veldkamp, 1899 J.A. Shafer s.n. G5:T5:S1 [*Hierochloe hirta* (Schrank) Borbas ssp. *arctica* (J. Presl) G. Weim.]

Anthoxanthum odoratum L., 1991 W.A. Zanol 695 Eurasia

Aristida dichotoma Michx. var. *dichotoma*, 1936 O.E. Jennings s.n.

Aristida oligantha Michx., 1982 W.W. Thomas and W.E. Buker 2978

Arrhenatherum elatius (L.) Beauv. ex J. & K. Presl var. *elatius*, 1998 S.A. Thompson and M. Burroughs 14388 Europe

Avena sativa L., 1945 W.E. Buker s.n. Europe [*Avena fatua* L. var. *sativa* (L.) Hausskn.]

Bromus arvensis L., 1992 W.A. Zanol 1164 Southern Europe [*Bromus japonicus* Thunb. ex Murr.]

Bromus inermis Leyss. ssp. *inermis* var. *inermis*, 1994 W.A. Zanol 2863 Europe

Bromus latiglumis (Shear) A.S. Hitchc., 1963 W.E. Buker s.n.

Bromus pubescens Muhl. ex Willd., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2277

Bromus racemosus L., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13476 Europe [*Bromus commutatus* Schrad.]

Bromus secalinus L., 1952 W.E. Buker s.n. Europe

Bromus sterilis L., 2002 B.L. Isaac and J.A. Isaac 14332 Europe

Bromus tectorum L., 1998 S.A. Thompson and M. Burroughs 14398 Europe

Calamagrostis canadensis (Michx.) Beauv. var. *canadensis*, 1929 J. Bright 1932

Cenchrus longispinus (Hack.) Fern., 1985 A.W. Cusick 25789

Chasmanthium latifolium (Michx.) Yates, 1898 B.H. Patterson s.n. G5:S1 [*Uniola latifolia* Michx.]

Cinna arundinacea L., 1998 B.L. Isaac and J.A. Isaac 11665

Dactylis glomerata L. ssp. *glomerata*, 2004 C. Tracey 2004-0003 Europe

Danthonia compressa Austin ex Peck, 2004 C. Tracey 2004-0005

Danthonia spicata (L.) Beauv. ex Roemer & J.A. Schultes, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13547

Deschampsia caespitosa (L.) Beauv. ssp. *caespitosa*, 1900 J.A. Shafer s.n. G5:S3

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13544

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann, 1991 W.A. Zanol 688 [*Panicum lanuginosum* Bosc ex Spreng., non Ell.]

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark, 1924 H.W. Graham s.n. [*Panicum lanuginosum* Bosc ex Spreng. var. *lindheimeri* (Nash) Fern.]

Dichanthelium boscii (Poir.) Gould & C.A. Clark, 1992 W.A. Zanol 1218 [*Panicum boscii* Poir.]

Dichanthelium clandestinum (L.) Gould, 1997 S.A. Thompson and B.L. Isaac 14160 [*Panicum clandestinum* L.]

Dichanthelium commutatum (J.A. Schultes) Gould, 1921 O.E. Jennings s.n. [*Panicum commutatum* J.A. Schultes]

Dichanthelium depauperatum (Muhl.) Gould, 1908 B.H. Patterson s.n. [*Panicum depauperatum* Muhl.]

Dichanthelium dichotomum (L.) Gould var. *dichotomum*, 1952 W.E. Buker s.n. [*Panicum microcarpon* Muhl., non Muhl. ex Ell.]

Dichanthelium latifolium (L.) Gould & C.A. Clark, 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2272 [*Panicum latifolium* L.]

Dichanthelium linearifolium (Scribn. ex Nash) Gould, 1921 J. Bright s.n. [*Panicum linearifolium* Scribn. ex Nash var. *werneri* (Scribn.) Fern.]

Dichanthelium sabulorum (Lam.) Gould & C.A. Clark var. *thinium* (A.S. Hitchc. & Chase) Gould, 1884 J.A. Shafer s.n. [*Panicum columbianum* Scribn.]

Digitaria ischaemum (Schreb.) Schreb. ex Muhl., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15116 Eurasia

Digitaria sanguinalis (L.) Scop., 1990 W.A. Zanol 182

Echinochloa crus-galli (L.) Beauv., 1998 S.A. Thompson 14924 Eurasia

Echinochloa frumentacea Link, 1946 W.E. Buker s.n. Eurasia [*Echinochloa crus-galli* (L.) Beauv. var. *frumentacea* (Link) W. Wight]

Echinochloa muricata (Beauv.) Fern. var. *muricata*, 1953 W.E. Buker s.n. Eurasia

Eleusine indica (L.) Gaertn., 1997 S.A. Thompson and B.L. Isaac 13876 Old World Tropics

Elymus canadensis L., 1969 W.E. Buker s.n.

Elymus hystrix L. var. *bigeloviana* (Fern.) Bowden, 1912 H.H. Smith s.n. [*Hystrix patula* Moench var. *bigeloviana* (Fern.) Deam]

Elymus hystrix L. var. *hystrix*, 1994 W.A. Zanol 3483

Elymus repens (L.) Gould, 1998 S.A. Thompson 14914 Eurasia [*Agropyron repens* (L.) Beauv. var. *subulatum* (Schreb.) Roemer & J.A. Schultes]

Elymus riparius Wieg., 1990 W.A. Zanol 304

Elymus villosus Muhl. ex Willd., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2295

Elymus virginicus L. var. *virginicus*, 1997 S.A. Thompson and B.L. Isaac 13873

Eragrostis capillaris (L.) Nees, 1982 W.W. Thomas and W.E. Buker 2982

Eragrostis cilianensis (All.) Vign. ex Janchen, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13602 Europe

Eragrostis frankii C.A. Mey. ex Steud., 1924 J. Bright s.n.

Eragrostis hypnoides (Lam.) B.S.P., 1991 W.A. Zanol 894

Eragrostis minor Host, 1997 S.A. Thompson and B.L. Isaac 14184 Europe

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea*, 1963 W. Margadant s.n.

Eragrostis pilosa (L.) Beauv. var. *pilosa*, 1929 J. Bright 1958

Eragrostis spectabilis (Pursh) Steud., 1970 W.E. Buker s.n.

Festuca filiformis Pourret, 1887 B.H. Patterson s.n. Exotic [*Festuca capillata* Lam.]

Festuca ovina L., 1956 M.G. Netting s.n. Europe

Festuca paradoxa Desv., 1887 B.H. Patterson s.n. G5:S1

Festuca pratensis Huds., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13545 Europe [*Schedonorus pratensis* (Huds.) Beauv.]

Festuca rubra L. ssp. *rubra*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13549

Festuca subverticillata (Pers.) Alexeev, 1979 D.E. Boufford and E.W. Wood 21099 [*Festuca obtusa* Biehler]

Festuca trachyphylla (Hack.) Krajina nom. Illeg., 1970 W.E. Buker s.n. Europe [*Festuca brevipila* Tracey]

Glyceria canadensis (Michx.) Trin., 1916 J. Bright s.n.

Glyceria grandis S. Wats. var. *grandis*, 1915 J. Bright s.n.

Glyceria septentrionalis A.S. Hitchc., 1934 J. Bright 9307

Glyceria striata (Lam.) A.S. Hitchc., 2004 C. Tracey and M. Takacs 2004-0016

Holcus lanatus L., 1998 K. McGowan and M. Scanlon 211 Europe

Hordeum jubatum L. ssp. *jubatum*, 1997 S.A. Thompson and B.L. Isaac and M. Sally 13464

Hordeum vulgare L., 1994 S.A. Thompson 11725 Eurasia

Miscanthus sinensis Anderss., 1969 W.E. Buker s.n. China

Muhlenbergia frondosa (Poir.) Fern., 1997 S.A. Thompson and B.L. Isaac 14161

Muhlenbergia glomerata (Willd.) Trin., 1990 W.A. Zanol 325

Muhlenbergia mexicana (L.) Trin., 1990 W.A. Zanol 398

Muhlenbergia schreberi J.F. Gmel., 1998 B.L. Isaac and J.A. Isaac 11663

Muhlenbergia sobolifera (Muhl. ex Willd.) Trin., 1912 B.H. Patterson s.n.

Muhlenbergia sylvatica Torr. ex A. Gray, 1909 O.E. Jennings s.n.

Muhlenbergia tenuiflora (Willd.) B.S.P., 1923 J. Bright s.n.

Panicum capillare L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15204

Panicum dichotomiflorum Michx. var. *dichotomiflorum*, 1990 W.A. Zanol 343

Panicum gattingeri Nash, 1902 O. Hatry s.n.

Panicum miliaceum L. ssp. *miliaceum*, 1998 A.W. Cusick 34526 Eurasia

Panicum philadelphicum Bernh. ex Trin., 1917 E.M. Gress s.n.

Panicum virgatum L. var. *virgatum*, 1996 L.L. Smith and R. Hawk 81

Pennisetum glaucum (L.) R. Br., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13550 Africa [*Setaria glauca* (L.) Beauv.]

Phalaris arundinacea L., 1992 W.A. Zanol 1161

Phalaris canariensis L., 1947 W.E. Buker s.n. Europe

Phleum pratense L., 1998 S.A. Thompson 14916 Europe

Phragmites australis (Cav.) Trin. ex Steud. ssp. *australis,* 1993 W.A. Zanol 2136

Poa alsodes A. Gray, 1998 K. McGowan and M. Scanlon 197

Poa annua L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15114 Eurasia

Poa compressa L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13548 Europe

Poa cuspidata Nutt., 1991 W.A. Zanol 468

Poa palustris L., 1944 O.E. Jennings s.n.

Poa pratensis L. ssp. *pratensis,* 1998 K. McGowan and M. Scanlon 159

Poa sylvestris A. Gray, 1998 K. McGowan and M. Scanlon 105

Poa trivialis L., 1998 K. McGowan and M. Scanlon 216 Europe

Puccinellia distans (Jacq.) Parl., 1985 A.W. Cusick 24315

Leersia oryzoides (L.) Sw., 1944 L.K. Henry s.n.

Leersia virginica Willd., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15124

Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, 1986 A.W. Cusick 25780

Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot, 1994 W.A. Zanol 3493 Europe [*Lolium multiflorum* Lam.]

Lolium perenne L. ssp. *perenne,* 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13546 Europe

Schizachyrium scoparium (Michx.) Nash var. *scoparium,* 1945 W.E. Buker s.n.

Secale cereale L., 1884 J.A. Shafer s.n. Eurasia

Setaria faberi Herrm., 1994 W.A. Zanol 3488 Eastern Asia

Setaria italica (L.) Beauv., 1924 J. Bright s.n. Eurasia

Setaria pumila (Poir.) Roemer & J.A. Schultes ssp. *pumila,* 1954 O.E. Jennings s.n. Europe [*Setaria glauca* (L.) Beauv.]

Setaria verticillata (L.) Beauv., 1979 F.H. Utech 79-335 Eurasia

Setaria viridis (L.) Beauv. var. *viridis,* 1929 W.R. VanDersal 321 Eurasia

Sorghastrum nutans (L.) Nash, 1946 W.E. Buker s.n.

Sorghum halepense (L.) Pers., 1924 S. Bright s.n. Mediterranean

Spartina pectinata Bosc ex Link, 1945 W.E. Buker s.n.

Sphenopholis intermedia (Rybd.) Rybd., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13542

Sphenopholis nitida (Biehler) Scribn., 1925 J. Bright s.n.

Sphenopholis obtusata (Michx.) Scribn., 1928 J. Bright 466

Sporobolus compositus (Poir.) Merr. var. *compositus,* 1902 B.H. Patterson s.n. [*Sporobolus asper* (Beauv.) Kunth]

Sporobolus neglectus Nash, 1895 B.H. Patterson s.n.

Sporobolus vaginiflorus (Torr. ex A. Gray) Wood var. *vaginiflorus,* 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15209

Tridens flavus (L.) A.S. Hitchc. var. *flavus,* 1997 S.A. Thompson and B.L. Isaac 14157

Triticum aestivum L., 1992 W.A. Zanol 1114 Eurasia

Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fern., 1890 B.H. Patterson s.n.

Zea mays L. ssp. *mays,* 1945 O.T. Jiel s.n. Tropical America

Polemoniaceae

Phlox divaricata L. ssp. *divaricata,* 1991 W.A. Zanol 520

Phlox maculata L. ssp. *maculata,* 1923 M. Stewart s.n.

Phlox paniculata L., 2001 S.N. Costabile 20

Phlox subulata L. ssp. *subulata,* 1991 W.A. Zanol 507

Polemonium reptans L. var. *reptans,* 1991 W.A. Zanol 480

Polygalaceae

Polygala ambigua Nutt., 1955 W.E. Buker s.n. [*Polygala verticillata* L. var. *ambigua* (Nutt.) Wood]

Polygala sanguinea L., 1985 M. Macdonald and K. Stewart LSCW146

Polygala verticillata L. var. *isocycla* Fern., 1909 B.H. Patterson s.n.

Polygala verticillata L. var. *verticillata,* 1939 W.G. Burig s.n.

Polygonaceae

Fallopia baldschuanica (Regel) Holub, 1931 J. Bright 5890 Asia [*Polygonum aubertii* Henry]

Fallopia cilinodis (Michx.) Holub, 1946 W.E. Buker s.n. [*Polygonum cilinode* Michx.]

Fallopia convolvulus (L.) A. Love, 1968 N.R. Farnsworth s.n. Europe [*Polygonum convolvulus* L.]

Fallopia japonica (Houtt.) R. Decr., 1998 K. McGowan and M. Scanlon 320 Japan [*Polygonum cuspidatum* Sieb. & Zucc.]

Fallopia sachalinensis (F. Schmidt ex Maxim.) R. Decr., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14124 Asia [*Polygonum sachalinense* F. Schimdt ex Maxim.]

Fallopia scandens (L.) Holub, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15123 [*Polygonum scandens* L.]

Persicaria amphibia (L.) S.F. Gray p.p., var. *emersa* (Michx.) Hickman, 1969 W.E. Buker s.n. [*Polygonum amphibium* L. var. *emersum* Michx.]

Persicaria arifolia (L.) Harolds., 1919 O.E. Jennings s.n. [*Polygonum arifolium* L.]

Persicaria hydropiper (L.) Opiz, 1927 W.C. Grimm 225 Europe [*Polygonum hydropiper* L.]

Persicaria hydropiperoides (Michx.) Small, 1912 O.E. Jennings s.n. [*Polygonum hydropiperoides* Michx.]

Persicaria lapathifolia (L.) S.F. Gray, 1990 W.A. Zanol 400 [*Polygonum lapathifolium* L.]

Persicaria longiseta (de Bruyn) Modenke, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13552 [*Polygonum caespitosum* Blume var. *longisetum* (de Bruyn) A.N. Steward]

Persicaria maculosa S.F. Gray, 1998 S.A. Thompson 14929 Europe [*Polygonum persicaria* L.]

Persicaria orientalis (L.) Spach, 1968 W.E. Buker s.n. India [*Polygonum orientale* L.]

Persicaria pensylvanica (L.) Small, 1990 W.A. Zanol 250 [*Polygonum pensylvanicum* L. ssp. *pensylvanicum*]

Persicaria perfoliata (L.) H. Gross, 2002 B.L. Isaac and J.A. Isaac 14333 Asia [*Polygonum perfoliatum* L.]

Persicaria posumbu (Buch.-Ham. ex D. Don) H. Gross, 1990 W.A. Zanol 269 Asia [*Polygonum caespitosum* Blume var. *caespitosum*]

Persicaria punctata (Ell.) Small, 1998 S.A. Thompson and B.L.

Isaac and J.A. Isaac 15136 [*Polygonum punctatum* Ell. var. *confertiflorum* (Meisn.) Fassett]

Persicaria sagittata (L.) Gross., 1998 K. McGowan and M. Scanlon 344 [*Polygonum sagittatum* L.]

Persicaria virginiana (L.) Gaertn., 1998 K. McGowan and M. Scanlon 294 [*Polygonum virginianum* L.]

Polygonum aviculare L. ssp. *aviculare*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13582 Europe

Polygonum erectum L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13585

Rumex acetosella L., 1998 K. McGowan and M. Scanlon 134 Eurasia *Rumex obtusifolius* L., 1998 K. McGowan and M. Scanlon 222 Europe

Rumex altissimus Wood, 1958 W.E. Buker s.n.

Rumex britannica L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13567 [*Rumex orbiculatus* A. Gray]

Rumex crispus L. ssp. *crispus*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13553 Europe

Rumex mexicanus Meisn., 1930 W.R. VanDersal 1736 [*Rumex salicifolius* Weinm. var. *mexicanus* (Meisn.) C.L. Hitchc.]

Pontederiaceae

Pontederia cordata L., 2002 M. Toogood s.n.

Portulacaceae

Claytonia caroliniana Michx., 1984 B. Behrer and M. Macdonald LSCW 30

Claytonia virginica L. var. *virginica*, 1998 K. McGowan and M. Scanlon 6

Portulaca oleracea L., 1990 W.A. Zanol 302

Potamogetonaceae

Potamogeton crispus L., 1975 J.M. Eggers 15 Europe

Potamogeton epihydrus Raf., 1933 W.R. Van Dersal s.n. [*Potamogeton epihydrus* Raf. var. *nuttallii* (Cham. & Schlect) Fern.]

Potamogeton foliosus Raf. ssp. *foliosus*, 1900 J.A. Shafer s.n.

Potamogeton illinoensis Morong, 1900 J.A. Shafer s.n.

Potamogeton nodosus Poir., 1923 J. Bright s.n.

Potamogeton perfoliatus L., 1900 J.A. Shafer s.n.

Potamogeton spirillus Tuckerman, 1923 J. Bright s.n.

Potamogeton tennesseensis Fern., 1975 J.M. Eggers 10 G2:S1

Primulaceae

Anagallis arvensis L. ssp. *arvensis*, 1962 M. Reynolds and F. Schell s.n. Eurasia

Dodecatheon meadia L. ssp. *meadia*, 1923 O.E. Jennings s.n. G5:S1

Lysimachia ciliata L., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2304

Lysimachia clethroides Duby, 1981 I. Pollack s.n. Asia

Lysimachia lanceolata Walt., 1945 L.K. Henry s.n.

Lysimachia nummularia L., 1990 W.A. Zanol 96 Europe

Lysimachia quadrifolia Sims, 1991 W.A. Zanol 587

Lysimachia terrestris (L.) B.S.P., 1993 W.A. Zanol 2146

Lysimachia vulgaris L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13595 Eurasia

Pyrolaceae

Chimaphila maculata (L.) Pursh, 1945 W.E. Buker s.n.

Chimaphila umbellata (L.) W. Bart. ssp. *cisatlantica* (Blake) Hulten, 1945 L.K. Henry s.n.

Pyrola americana Sweet, 1932 C.M. Hepner s.n.

Pyrola elliptica Nutt., 1945 W.E. Buker s.n.

Ranunculaceae

Actaea pachypoda Ell., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15156 [*Actaea alba* auct. non (L.) P. Mill.]

Actaea racemosa L., 1964 W.D. Loub and E.E. Maloney WP-796 [*Cimicifuga racemosa* (L.) Nutt.]

Anemone canadensis L., 1912 J. Bright s.n.

Anemone quinquefolia L. var. *quinquefolia*, 1986 M. Macdonald and J. Konrad LSCW163

Anemone virginiana L. var. *virginiana*, 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2285

Aquilegia canadensis L., 1991 W.A. Zanol 525

Aquilegia vulgaris L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13605 Europe

Caltha palustris L. var. *palustris*, 1915 O.E. Jennings and G.K. Jennings s.n. [*Caltha palustris* L. var. *flabellifolia* (Pursh) Torr. & A. Gray]

Clematis viorna L., 1873 B.H. Patterson s.n. G5:S1

Clematis virginiana L., 1990 W.A. Zanol 194

Delphinium exaltatum Ait., 1950 W.E. Buker s.n. G3:S1

Delphinium tricorne Michx., 1992 W.A. Zanol 969

Ficaria verna Huds., 1986 M. Macdonald and J. Konrad LSCW167 Eurasia [*Ranunculus ficaria* L. ssp. *bulbifera* Lambinon]

Helleborus viridis L., 1942 E.H. McClelland s.n. Europe

Hepatica nobilis Schreber var. *acuta* (Pursh) Steyermark, 1991 W.A. Zanol 463 [*Hepatica acutiloba* DC.]

Hepatica nobilis Schreber var. *obtusa* (Pursh) Steyermark, 1991 W.A. Zanol 424 [*Hepatica americana* (DC.) Ker-Gawl]

Hydrastis canadensis L., 1950 W.E. Buker s.n. G4:S4

Ranunculus abortivus L., 1998 K. McGowan and M. Scanlon 173

Ranunculus acris L. var. *acris*, 1945 L.K. Henry s.n. Europe

Ranunculus allegheniensis Britt., 1945 O.E. Jennings s.n.

Ranunculus ambigens S. Wats., 1912 J. Bright s.n. G4:S3

Ranunculus bulbosus L., 1998 K. McGowan and M. Scanlon 126 Europe

Ranunculus flabellaris Raf., 1930 J. Bright 2477 G5:S2

Ranunculus hispidus Michx. var. *hispidus*, 1992 W.A. Zanol 979

Ranunculus hispidus Michx. var. *nitidus* (Chapman) T. Duncan, 1993 F.W. Wright Jr. 109 [*Ranunculus septentrionalis* Poir.]

Ranunculus micranthus Nutt., 1997 J.D. Wagner and S. Grund 1493

Ranunculus recurvatus Poir. var. *recurvatus*, 2002 B.L. Isaac and J.A. Isaac 14383

Ranunculus repens L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13581 Europe

Ranunculus sceleratus L. var. *sceleratus*, 1998 B.L. Isaac and J.A. Isaac 11740

Thalictrum dioicum L., 1994 W.A. Zanol 2444

Thalictrum pubescens Pursh, 1990 W.A. Zanol 27

Thalictrum revolutum DC., 1921 J. Bright s.n.

Thalictrum thalictroides (L.) Eames & Boivin, 1992 W.A. Zanol 1222

Trautvetteria caroliniensis (Walter) Vail var. *caroliniensis*, 1888 C.D. Beadle herbarium s.n. G5:S3

Rhamnaceae

Ceanothus americanus L., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2266
Frangula alnus P. Mill., 2002 S.P. Grund and M.L. Speedy 2901 Europe and Western Asia
Rhamnus alnifolia L'Her., 1959 W.E. Buker s.n.
Rhamnus cathartica L., 2002 B.L. Isaac and J.A. Isaac 14344 Europe

Rosaceae

Agrimonia gryposepala Wallr., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15133
Agrimonia microcarpa Wallr., 1969 W.E. Buker s.n. [*Agrimonia pubescens* Wallr. var. *microcarpa* (Wallr.) Ahles]
Agrimonia parviflora Ait., 1991 W.A. Zanol 867
Agrimonia pubescens Wallr., 1955 L.K. Henry
Agrimonia rostellata Wallr., 1912 J. Bright 26
Amelanchier arborea (Michx. f.) Fern., 1947 L.K. Henry s.n.
Amelanchier canadensis (L.) Medik., 1899 J.A. Shafer s.n. G5:SNR
Amelanchier laevis Wieg., 1899 J.A. Shafer s.n.
Amelanchier sanguinea (Pursh) DC. var. *sanguinea*, 1946 W.E. Buker s.n. G5:S1 [*Amelanchier humilis* Wieg.]
Amelanchier spicata (Lam.) K. Koch, 1939 O.E. Jennings s.n. [*Amelanchier stolonifera* Wieg.]
Amelanchier x intermedia Spach (pro sp.), 1950 W.E. Buker s.n.
Aruncus dioicus (Walt.) Fern. var. *dioicus*, 1997 S.A. Thompson and B.L. Isaac and R. Goto and T. Collins 14204
Crataegus brainerdii Sarg., 1923 J. Bright s.n. G5:SU
Crataegus comata Sarg., 2002 J.A. Macklin and B. Isaac and J. Isaac 2002.12
Crataegus compacta Sarg., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15144
Crataegus crus-galli L., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15143
Crataegus disperma Ashe, 1907 O.E. Jennings and G.K. Jennings tree 29 [*Crataegus punctata* Jacq. var. *pausiaca* (Ashe) Palmer]
Crataegus dissona Sarg., 1909 O.E. Jennings and G.K. Jennings s.n. [*Crataegus pruinosa* (Wendl. f.) K. Koch var. *dissona* (Sarg.) Egglest.]
Crataegus holmesiana Ashe, 1908 O.E. Jennings OEJ 22
Crataegus intricata Lange, 1909 O.E. Jennings tree 54 [*Crataegus biltmoreana* Beadle]
Crataegus iracunda Beadle, 2001 J.A. Isaac 13623 [*Crataegus brumalis* Ashe]
Crataegus jesupii Sarg., 1909 O.E. Jennings tree 68 [*Crataegus filipes* Ashe]
Crataegus macrosperma Ashe, 1950 W.E. Buker s.n.
Crataegus monogyna Jacq., 1965 N.R. Farnsworth WP-1029 Eurasia
Crataegus pedicellata Sarg., 2001 J.A. Isaac 13540 [*Crataegus coccinea* L. p.p.]
Crataegus pennsylvanica Ashe, 2002 B.L. Isaac and J.A. Isaac 14539 G3Q:S2S3
Crataegus pringlei Sarg., 1924 J. Bright s.n.
Crataegus pruinosa (Wendl. F.) K. Koch, 1909 O.E. Jennings tree 38
Crataegus punctata Jacq., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14372
Crataegus scabrida Sarg., 2002 J.A. Macklin and B. Isaac and J. Isaac 2002.14 [*Crataegus scabrida* Sarg. var. *asperifolia* (Sarg.) Kruschke]
Crataegus succulenta Schrad. ex Link, 1925 J. Bright s.n.
Crataegus uniflora Muenchh., 1904 B.H. Patterson s.n.
Cydonia oblonga P. Mill., 1928 J. Bright 42 Eurasia
Drymocallis arguta (Pursh) Rydb. ssp. *arguta*, 1902 J.E. Winner s.n. [*Potentilla arguta* Pursh ssp. *arguta*]
Duchesnea indica (Andr.) Focke, 1997 J.A. Isaac and B.L. Isaac 10179 Asia
Filipendula rubra (Hill) B.L. Robins., 1977 W.E. Buker s.n. G4G5:S1S2
Fragaria vesca L. ssp. *americana* (Porter) Staudt, 1924 J. Bright s.n.
Fragaria vesca L. ssp. *vesca*, 1946 W.E. Buker s.n.
Fragaria virginiana Duchesne ssp. *grayana* (Vilm. ex J. Gay) Staudt, 1946 E. Mason s.n.
Fragaria virginiana Duchesne ssp. *virginiana*, 1998 K. McGowan and M. Scanlon 89
Geum canadense Jacq. var. *canadense*, 1998 S.A. Thompson and B.L. Isaac 14959
Geum laciniatum Murr. var. *laciniatum*, 1990 W.A. Zanol 184
Geum laciniatum Fern. var. *trichocarpum* Fern., 1909 O.E. Jennings s.n.
Geum rivale L., 1944 O.E. Jennings s.n.
Geum urbanum L., 1909 W. Dole s.n. Eurasia
Geum vernum (Raf.) Torr. & A. Gray, 1998 K. McGowan and M. Scanlon 148
Geum virginianum L., 1919 O.E. Jennings s.n.
Gillenia trifoliata (L.) Moench, 1955 E. Mason s.n. [*Porteranthus trifoliatus* (L.) Britt.]
Malus baccata (L.) Borkh., 1998 K. McGowan and M. Scanlon 372 Eurasia
Malus coronaria (L.) P. Mill., 1992 W.A. Zanol 976
Malus prunifolia (Willd.) Borkh., 1998 K. McGowan and M. Scanlon 306 Asia
Malus pumila P. Mill., 1998 B.L. Isaac and M. Rosenberger 10213 Eurasia [*Pyrus malus* L.]
Malus toringo (Sieb.) Sieb. ex de Vriese, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15090 Eastern Asia [*Malus sieboldii* (Regel) Rehd.]
Photinia floribunda (Lindl.) Robertson & Phipps, 1900 J.A. Shafer s.n. [*Pyrus floribunda* Lindl.]
Photinia melanocarpa (Michx.) Robertson & Phipps, 1909 O.E. Jennings s.n. [*Pyrus melanocarpa* (Michx.) Willd.]
Photinia pyrifolia (Lam.) Robertson & Phipps, 1932 C.M. Hepner s.n. [*Pyrus floribunda* Lindl.]
Physocarpus opulifolius (L.) Maxim. var. *opulifolius*, 1998 K. McGowan and M. Scanlon 238
Potentilla canadensis L. var. *canadensis*, 1916 B.H. Patterson s.n.
Potentilla canadensis L. var. *villosissima* Fern., 2001 S.N. Costabile 4
Potentilla intermedia L., 1982 W.E. Buker s.n. Eurasia
Potentilla norvegica L. ssp. *monspeliensis* (L.) Aschers. &

Graebn., 1994 F.H. Utech and T.D. Jacobsen and R.W. Kiger 94-2289
Potentilla recta L., 1998 S.A. Thompson 14917 Europe
Potentilla simplex Michx., 1998 K. McGowan and M. Scanlon 176
Prunus americana Marsh., 1945 L.K. Henry s.n.
Prunus avium (L.) L., 1999 B.L. Isaac and T. Herman 11778 Eurasia
Prunus cerasus L., 1922 J. Bright s.n. Eurasia
Prunus mahaleb L., 1997 F.H. Utech 97-162 Europe
Prunus padus L., 1978 N.D. Richmond s.n. Europe
Prunus pensylvanica L. f. var. *pensylvanica*, 1926 S.A. Auld s.n.
Prunus persica (L.) Batsch, 1979 E.W. Wood and D.E. Boufford and P. Singleton 4211 Asia
Prunus pumila L. var. *depressa* (Pursh) Gleason, 1900 J.A. Shafer s.n. G5T5:S1
Prunus serotina Ehrh. var. *serotina*, 2002 B.L. Isaac and J.A. Isaac 14368
Prunus virginiana L. var. *virginiana*, 1998 S.A. Thompson and B.L. Isaac 14963
Pyracantha coccinea M. Roemer, 1997 S.A. Thompson and B.L. Isaac 14167 Exotic
Pyrus communis L., 1998 B.L. Isaac and J.A. Isaac 11646 Eurasia
Rosa canina L., 1996 L.L. Smith and R. Hawk 44 Europe
Rosa carolina L. var. *carolina*, 2003 C.M. Bowers s.n.
Rosa blanda Aiton var. *blanda*, 1884 J.A. Shafer s.n. [*Rosa subblanda* Rydb.]
Rosa eglanteria L., 1955 E. Mason s.n. Europe [*Rosa rubiginosa* L.]
Rosa multiflora Thunb. ex Murr., 2002 M.L. Young and B.R. Swiech 7 Asia
Rosa palustris Marsh., 1945 L.K. Henry s.n.
Rosa setigera Michx. var. *tomentosa* Torr. & A. Gray, 1913 T.E. Kirch s.n. G5:SU
Rosa virginiana P.Mill. var. *virginiana*, 1918 B.H. Patterson s.n. G5:S1
Rhodotypos scandens (Thunb.) Makino, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13614 Japan
Rubus allegheniensis Porter var. *allegheniensis*, 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14352
Rubus caesius L., 1998 B.L. Isaac and J.A. Isaac 11722 Europe
Rubus deamii Bailey, 1905 O.E. Jennings s.n.
Rubus flagellaris Willd., 1998 K. McGowan and M. Scanlon 207
Rubus hispidus L., 1944 O.E. Jennings s.n.
Rubus idaeus L. ssp. *strigosus* (Michx.) Focke, 1925 C.K. Henlen 393 Exotic [*Rubus strigosus* Michx.]
Rubus laciniatus Willd., 1997 S.A. Thompson and B.L. Isaac and M.A. Rosenberger 14106 Europe
Rubus laudatus Berger, 1944 L.K. Henry s.n.
Rubus pensilvanicus Poir., 2002 B.L. Isaac and J.A. Isaac and S.P. Grund and McPherson 14351
Rubus pergratus Blanch., 1998 K. McGowan and M. Scanlon 274 [*Rubus orarius* Blanch.]
Rubus phoenicolasius Maxim., 1979 D.E. Boufford 21187 Asia
Rubus plicatifolius Blanch., 1918 O.E. Jennings s.n.
Rubus odoratus L. var. *odoratus*, 1991 W.A. Zanol 703
Rubus occidentalis L., 1998 K. McGowan and M. Scanlon 286
Rubus rosa Bailey, 1918 O.E. Jennings s.n.
Sanguisorba canadensis L., 1912 J. Bright s.n.
Sorbaria sorbifolia (L.) A. Braun, 1901 J.A. Shafer s.n. Asia
Spiraea alba Du Roi var. *alba*, 1945 L.K. Henry s.n.
Spiraea alba Du Roi var. *latifolia* (Ait.) Dippel, 1913 J. Bright s.n. [*Spiraea latifolia* (Aiton) Borkh.]
Spiraea prunifolia Sieb. & Zucc., 1946 W.E. Buker s.n. Asia
Spiraea tomentosa L., 1990 W.A. Zanol 206
Waldsteinia fragarioides (Michx.) Tratt. ssp. *fragarioides*, 1991 W.A. Zanol 528

Rubiaceae

Cephalanthus occidentalis L., 1996 S. Grund 1674
Diodia teres Walt., 1982 W.W. Thomas and W.E. Buker 2975
Galium aparine L., 1998 K. McGowan and M. Scanlon 184
Galium asprellum Michx., 1944 L.K. Henry s.n.
Galium boreale L., 1921 O.E. Jennings s.n.
Galium circaezans Michx., 1944 L.K. Henry s.n.
Galium concinnum Torr. & A. Gray, 1991 W.A. Zanol 818
Galium lanceolatum Torr., 1932 C.M. Hepner s.n.
Galium mollugo L., 1931 J. Bright 5404 Eurasia
Galium obtusum Bigelow ssp. *obtusum*, 1902 B.H. Patterson s.n.
Galium palustre L., 1917 B.H. Patterson s.n.
Galium pilosum Ait., 1937 F.R. Fosberg 14320
Galium tinctorium (L.) Scop., 1932 C.M. Hepner s.n.
Galium triflorum Michx., 1998 S.A. Thompson and B.L. Isaac 14966
Galium verum L. var. *verum*, 1961 V. Phelps s.n. Eurasia
Houstonia caerulea L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14379
Houstonia canadensis Willd. ex Roemer & J.A. Schultes, 1950 W.E. Buker s.n.
Houstonia longifolia Gaertn., 1946 W.E. Buker s.n.
Mitchella repens L., 1889 M.T. Shafer s.n.
Sherardia arvensis L., 1949 L.K. Henry s.n. Eurasia

Rutaceae

Ptelea trifoliata L. ssp. *trifoliata* var. *trifoliata*, 2002 B.L. Isaac and J.A. Isaac 14348 G5:S2
Zanthoxylum americanum P. Mill., 1900 J.A. Shafer s.n.

Salicaceae

Populus alba L., 1979 E.W. Wood and D.E. Boufford and L. Schram 4240 Eurasia
Populus deltoides Bartr. ex Marsh. ssp. *deltoides*, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13610
Populus grandidentata Michx., 1999 B.L. Isaac and T. Herman 11781
Populus nigra L., 1966 P. Monk s.n. Eurasia
Populus tremuloides Michx., 1997 S.A. Thompson and B.L. Isaac and M. Sally 13480
Populus x jackii Sarg., 1940 O.E. Jennings s.n.
Salix alba L., 1991 W.A. Zanol 454 Eurasia
Salix bebbiana Sarg., 1924 J. Bright s.n.
Salix caroliniana Michx., 1908 O.E. Jennings s.n. G5:S1
Salix discolor Muhl., 1992 W.A. Zanol 973
Salix eriocephala Michx., 2002 S.P. Grund and M.L. Speedy 2897

Salix exigua Nutt. var. *exigua,* 2002 B.L. Isaac and J.A. Isaac 14372 [*Salix interior* Rowlee]
Salix fragilis L., 1998 B.L. Isaac and J.A. Isaac 11725 Europe
Salix humilis Marsh. var. *humilis,* 1908 O.E. Jennings s.n. [*Salix humilis* Marsh. var. *hyporhysa* Fern.]
Salix humilis Marsh. var. *tristis* (Ait.) Griggs, 1902 J.A. Shafer s.n. [*Salix humilis* Marsh. var. *microphylla* (Anderss.) Fern.]
Salix lucida Muhl., 1925 J. Bright s.n.
Salix nigra Marsh., 1998 S.A. Thompson 14919
Salix petiolaris Sm., 1994 W.A. Zanol 3078 G5:S4
Salix purpurea L., 1982 W.E. Buker s.n. Europe
Salix sericea Marsh., 1919 O.E. Jennings s.n.

Santalaceae
Comandra umbellata (L.) Nutt ssp. *umbellata,* 1924 J. Bright s.n.

Saururaceae
Saururus cernuus L., 1956 D.T. Patterson s.n.

Saxifragaceae
Chrysosplenium americanum Schwein. ex Hook., 1928 J. Bright 17
Heuchera americana L. var. *americana,* 1965 N.R. Farnsworth WP-1050
Heuchera pubescens Pursh, 1904 A.D. Frost s.n.
Mitella diphylla L., 1991 W.A. Zanol 526
Saxifraga pensylvanica L., 1945 O.E. Jennings s.n.
Saxifraga virginiensis Michx. var. *virginiensis,* 1991 W.A. Zanol 471
Tiarella cordifolia L. var. *cordifolia,* 1923 J. Bright s.n.

Scrophulariaceae
Agalinis tenuifolia (Vahl) Raf. var. *tenuifolia,* 1998 K. McGowan and M. Scanlon 351
Antirrhinum majus L., 1997 S.A. Thompson and B.L. Isaac 14186 Europe
Aureolaria flava (L.) Farw. var. *flava,* 1907 O.E. Jennings s.n.
Aureolaria pedicularia (L.) Raf. var. *intercedens* Pennell, 1917 B.H. Patterson s.n.
Aureolaria virginica (L.) Pennell, 1907 D.A. Atkinson s.n.
Castilleja coccinea (L.) Spreng., 1886 J.A. Shafer s.n. G5:S2
Chaenorhinum minus (L.) Lange, 1997 S.A. Thompson 13438 Europe
Chelone glabra L., 1990 W.A. Zanol 368 [*Chelone glabra* L. var. *elatior* Raf.]
Collinsia verna Nutt., 1997 J.D. Wagner 1495 G5:S4
Gratiola neglecta Torr., 1945 W.E. Buker s.n.
Linaria vulgaris P. Mill., 2001 S.N. Costabile 2 Eurasia
Lindernia dubia (L.) Pennell var. *dubia,* 1994 W.A. Zanol 3079
Melampyrum lineare Desr. var. *lineare,* 1932 C.M. Hepner s.n. [*Melampyrum lineare* Desr. var. *americanum* (Michx.) Beauverd]
Mimulus alatus Ait., 1925 J. Bright s.n.
Mimulus ringens L. var. *ringens,* 1997 S.A. Thompson and B.L. Isaac 13856
Nuttallanthus canadensis (L.) D.A. Sutton, 1946 W.E. Buker s.n. G5:S4 [*Linaria canadensis* (L.) Chaz.]
Paulownia tomentosa (Thunb.) Sieb. & Zucc. ex Steud., 1991 W.A. Zanol 506 China
Pedicularis canadensis L. ssp. *canadensis,* 1945 L.K. Henry s.n.
Pedicularis lanceolata Michx., 1917 B.H. Patterson s.n. G5:S1S2
Penstemon digitalis Nutt. ex Sims, 1979 D.E. Boufford 21113
Penstemon hirsutus (L.) Willd., 1991 W.A. Zanol 690
Penstemon laevigatus Ait., 1948 D.H. Krouse s.n. G5:S3
Scrophularia lanceolata Pursh, 1933 C.T. Agostini s.n.
Scrophularia marilandica L., 1998 K. McGowan and M. Scanlon 315
Verbascum blattaria L., 2002 H. George s.n. Eurasia
Verbascum thapsus L., 1990 W.A. Zanol 95 Europe
Verbascum virgatum Stokes, 1945 W.E. Buker s.n. Europe
Veronica americana Schwein. ex Benth., 1992 W.A. Zanol 1224
Veronica arvensis L., 2002 B.L. Isaac and J.A. Isaac 14359 Eurasia
Veronica chamaedrys L., 1985 J. Konrad and M. Macdonald LSCW105 Eurasia
Veronica hederifolia L., 1978 W.E. Buker s.n. Eurasia
Veronica officinalis L., 1998 K. McGowan and M. Scanlon 166
Veronica peregrina L. ssp. *peregrina,* 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14308
Veronica persica Poir., 1991 W.A. Zanol 432 Eurasia
Veronica scutellata L., 1898 J.A. Shafer s.n.
Veronica serpyllifolia L. ssp. *serpyllifolia,* 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14382 Europe
Veronicastrum virginicum (L.) Farw., 1945 L.K. Henry s.n.

Simaroubaceae
Ailanthus altissima (P. Mill.) Swingle, 2002 H. George s.n. Asia

Smilacaceae
Smilax glauca Walt., 1908 B.H. Patterson s.n. [*Smilax glauca* Walt. var. *leurophylla* Blake]
Smilax herbacea L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14331
Smilax hispida Muhl. ex Torr., 1992 W.A. Zanol 1158 [*Smilax tamnoides* L.]
Smilax rotundifolia L., 1992 W.A. Zanol 1120

Solanaceae
Datura stramonium L., 1963 N.R. Farnsworth WP-537 Mexico
Datura wrightii Regel, 1960 R. Aborn s.n. [*Datura meteloides* auct. p.p. non Dunal]
Lycium barbarum L., 1998 B.L. Isaac and J.A. Isaac 11743 Eurasia
Nicandra physalodes (L.) Gaertn., 1885 J.A. Shafer s.n. Peru
Petunia x atkinsiana D. Don ex Loud., 1991 W.A. Zanol 808 South America [*Petunia x hybrida* Vilm.]
Physalis alkekengi L., 1965 N.R. Farnsworth WP-1127 Eurasia
Physalis heterophylla Nees var. *heterophylla,* 1998 S.A. Thompson 14915
Physalis longifolia Nutt. var. *subglabrata* (Mackenzie & Bush) Cronq., 1998 S.A. Thompson and B.L. Isaac 14940
Physalis pubescens L. var. *integrifolia* (Dunal) Waterfall, 1923 J. Bright s.n.
Physalis pubescens L. var. *pubescens,* 1950 W.E. Buker s.n.
Solanum carolinense L. var. *carolinense,* 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13609
Solanum dulcamara L. var. *dulcamara,* 2002 M.L. Young and B.R. Swiech 9 Eurasia

Solanum ptycanthum Dunal, 1994 W.A. Zanol 2852

Solanum rostratum Dunal, 1972 C. Cianchetti s.n. [*Solanum cornutum* auct. non Lam.]

Sparganiaceae

Sparganium americanum Nutt., 1936 J. Bright 13957

Sparganium eurycarpum Engelm. ex A. Gray, 1992 W.A. Zanol 1117

Staphyleaceae

Staphylea trifolia L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13612

Thymelaeaceae

Dirca palustris L., 1942 E.H. McClelland s.n.

Tiliaceae

Tilia americana L. var. *americana,* 1997 S.A. Thompson and B.L. Isaac 14148

Tilia americana L. var. *heterophylla* (Vent.) Loud., 1942 Duff s.n.

Tilia platyphyllos Scop., 2002 B.L. Isaac and J.A. Isaac 14361 Europe

Typhaceae

Typha angustifolia L., 1998 S.A. Thompson 14923 Europe

Typha latifolia L., 1994 W.A. Zanol 3779

Typha x glauca Godr. (pro sp.), 1924 J. Bright s.n.

Ulmaceae

Celtis occidentalis L., 1998 B.L. Isaac and J.A. Isaac 11724

Ulmus americana L., 1999 B.L. Isaac and T. Herman 11777

Ulmus pumila L., 1998 B.L. Isaac and M. Rosenberger 10207 Asia

Ulmus rubra Muhl., 1998 B.L. Isaac and J.A. Isaac 11585

Ulmus thomasii Sarg., 1889 J. Furgeson s.n.

Urticaceae

Boehmeria cylindrica (L.) Sw., 1993 W.A. Zanol 2068

Laportea canadensis (L.) Weddell, 1990 W.A. Zanol 160

Parietaria pensylvanica Muhl. ex Willd., 2002 B.L. Isaac and J.A. Isaac 14341

Pilea pumila (L.) A. Gray, 1997 S.A. Thompson and B.L. Isaac 14143

Urtica dioica L. ssp. *dioica,* 1985 M. Macdonald and K. Stewart LSCW134 Europe

Urtica dioica L. ssp. *gracilis* (Ait.) Seland., 1997 S.A. Thompson and B.L. Isaac 13883

Valerianaceae

Valeriana officinalis L., 1897 C.C. Mellor s.n. Eurasia

Valeriana pauciflora Michx., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14316

Valerianella chenopodiifolia (Pursh) DC., 1998 K. McGowan and M. Scanlon 92

Valerianella locusta (L.) Lat., 1902 J.A. Shafer s.n. Europe

Valerianella umbilicata (Sullivant) Wood, 1945 O.E. Jennings s.n.

Verbenaceae

Phryma leptostachya L., 1920 M. Knauz s.n.

Verbena bonariensis L. var. *bonariensis,* 1998 B.L. Isaac and J.A. Isaac 11742 South America

Verbena hastata L., 1990 W.A. Zanol 110

Verbena stricta Vent., 1922 J. Bright s.n.

Verbena urticifolia L., 1998 K. McGowan and M. Scanlon 335

Violaceae

Hybanthus concolor (T.F. Forst.) Spreng., 1963 W.E. Buker s.n.

Viola affinis Le Conte, 1992 W.A. Zanol 980

Viola arvensis Murray, 1993 R.S. Fox s.n. Europe

Viola bicolor Pursh, 1919 E.M. Gress s.n.

Viola blanda Willd. var. *blanda,* 1946 W.E. Buker s.n.

Viola canadensis L. var. *canadensis,* 1940 L.K. Henry s.n.

Viola cucullata Ait., 1996 R.W. Kiger 806

Viola hirsutula Brainerd, 1922 J. Bright s.n.

Viola labradorica Schrank, 1929 E.H. Graham s.n.

Viola lanceolata L. ssp. *lanceolata,* 1923 J. Bright s.n.

Viola odorata L., 1998 B.L. Isaac and M. Rosenberger 10216 Europe

Viola palmata L., 1992 W.A. Zanol 983 [*Viola stoneana* House]

Viola pubescens Ait., 1997 S.A. Thompson and M. Sally 13505

Viola rostrata Pursh, 1991 W.A. Zanol 472

Viola sagittata Ait. var. *ovata* (Nutt.) Torr. & A. Gray, 1991 W.A. Zanol 497

Viola sagittata Ait. var. *sagittata,* 1991 W.A. Zanol 449

Viola sororia Willd., 1998 K. McGowan and M. Scanlon 16

Viola striata Ait., 1998 K. McGowan and M. Scanlon 152

Viola tricolor L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14352 Europe

Viola x bernardii Greene (Greene), 1922 J. Bright s.n. [*Viola subsinuata* (Greene) Greene]

Viola x cordifolia (Nutt.) Schwein. (pro sp.), 1949 L.K. Henry 9

Viola x porteriana Pollard (pro sp.), 1906 O.E. Jennings and G.E. Kinzer s.n.

Viola x primulifolia L. (pro sp.), 1898 J.A Shafer s.n. [*Viola primulifolia* L.]

Vitaceae

Ampelopsis brevipedunculata (Maxim.) Trautv., 2002 H. George s.n. Asia

Parthenocissus quinquefolia (L.) Planch., 1998 K. McGowan and M. Scanlon 199

Parthenocissus tricuspidata (Sieb. & Zucc.) Planch., 1998 B.L. Isaac and J.A. Isaac 11744 China and Japan

Parthenocissus vitacea (Knerr) A.S. Hitchc., 1990 W.A. Zanol 20

Vitis aestivalis Michx. var. *bicolor* Deam, 1992 W.A. Zanol 1231

Vitis cinerea (Engelm.) Millard var. *baileyana* (Munson) Comeaux, 1919 O.E. Jennings s.n. G4G5TNR:SH

Vitis labrusca L., 1917 B.H. Patterson s.n.

Vitis riparia Michx., 1997 S.A. Thompson and B.L. Isaac 13845

Vitis vulpina L., 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13573

Vitis x novae-angliae Fern. (pro sp.), 1912 B.H. Patterson s.n. G4G5Q:S1

Zygophyllaceae

Tribulus terrestris L., 1984 W.E. Buker s.n. Mediterranean

EQUISETOPHYTES

Equisetaceae

Equisetum arvense L., 2002 B.L. Isaac and J.A. Isaac 14363

Equisetum fluviatile L., 1910 L.S. Hopkins s.n.

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eat., 1939 L.K. Henry and E.S. Henry s.n.

Equisetum sylvaticum L., 1902 J.A. Shafer s.n.

Equisetum x litorale Kuhlewein ex Rupr. (pro sp.), 1931 A.B. Lord s.n.

GYMNOSPERMS

Cupressaceae

Juniperus virginiana L. var. *virginiana*, 1942 J. Murdock s.n.

Ginkgoaceae

Ginkgo biloba L., 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14311 China

Pinaceae

Larix decidua P. Mill., 1998 S.A. Thompson and B.L. Isaac 14947 Europe

Picea abies (L.) Karst., 1990 W.A. Zanol 414 Europe

Picea pungens Engelm., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15108

Pinus resinosa Ait., 1915 O.E. Jennings 5467

Pinus rigida P. Mill., 1921 O.E. Jennings s.n.

Pinus strobus L., 1965 P.B. Monk s.n.

Pinus sylvestris L., 1998 S.A. Thompson and B.L. Isaac 14967 Eurasia

Pinus virginiana P. Mill., 1936 J.A. Churchill 188

Tsuga canadensis (L.) Carr., 1991 W.A. Zanol 423

Taxaceae

Taxus canadensis Marsh., 1917 O.E. Jennings s.n. G5:S3S4

LYCOPHYTES

Lycopodiaceae

Dendrolycopodium dendroideum (Michx.) Haines, 1947 W.E. Buker s.n. [*Lycopodium dendroideum* Michx.]

Dendrolycopodium hickeyi (W.H. Wagner, Beitel & Moran) Haines, 2002 S.P. Grund and M.L. Speedy 2892 [*Lycopodium hickeyi* W.H. Wagner, Beitel & Moran]

Dendrolycopodium obscurum (L.) Haines, 2004 S.R. Miller 14 [*Lycopodium obscurum* L.]

Huperzia lucidula (Michx.) Trevisan, 1949 L.K. Henry s.n.

Lycopodium clavatum L., 1946 W.E. Buker s.n.

Lycopodium digitatum Dill. ex A. Braun, 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15166 [*Diphasiastrum digitatum* (Dill.ex A. Braun) Holub]

Lycopodium lagopus (Laestad. Ex Hartm.) Zinserl., 1947 W.E. Buker s.n.

Lycopodium tristachyum Purch, 1921 O.E. Jennings s.n. [*Diphasiastrum tristachyum* (Pursh) Holub]

Lycopodium x habereri House, 1946 W.E. Buker s.n. [*Diphasiastrum x habereri* (House) Holub]

Selaginellaceae

Selaginella apoda (L.) Spring, 2002 B.L. Isaac and J.A. Isaac 14364

POLYPODIOPHYTES

Aspleniaceae

Asplenium montanum Willd., 1999 L. Savage s.n.

Asplenium platyneuron (L.) B.S.P. var. *platyneuron*, 1998 S.A. Thompson and B. Isaac and J. Isaac and F.H. Utech 14360

Asplenium rhizophyllum L., 1945 L.K. Henry s.n.

Asplenium trichomanes L. ssp. *trichomanes*, 1921 O.E. Jennings s.n.

Dennstaedtiaceae

Dennstaedtia punctilobula (Michx.) T. Moore, 2001 S.N. Costabile 6

Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underwood ex Heller, 1940 R.W. Little s.n.

Dryopteridaceae

Athyrium filix-femina (L.) Roth ssp. *angustum* (Willd.) Clausen, 1998 K. McGowan and M. Scanlon 298

Athyrium filix-femina (L.) Roth ssp. *asplenioides* (Michx.) Hulten, 1945 W.E. Buker s.n.

Cystopteris bulbifera (L.) Bernh., 2001 J.A. Isaac 13541

Cystopteris protrusa (Weatherby) Blasdell, 1996 S. Grund 1676

Cystopteris tenuis (Michx.) Desv., 2001 J.A. Isaac 13540

Deparia acrostichoides (Sw.) M. Kato, 1945 L.K. Henry s.n. [*Athyrium thelypterioides* (Michx.) Desv.]

Diplazium pycnocarpon (Spreng.) Broun, 1985 C.C. Mellor, herbarium s.n. [*Athyrium pycnocarpon* (Spreng.) Tidestrom]

Dryopteris carthusiana (Vill.) H.P. Fuchs, 2002 B.L. Isaac and J.A. Isaac 14375

Dryopteris cristata (L.) A. Gray, 1945 W.E. Buker s.n.

Dryopteris filix-mas (L.) Schott, 2000 J.E. Gottlieb s.n.

Dryopteris goldiana (Hook. ex Goldie) A. Gray, 1945 W.E. Buker s.n.

Dryopteris intermedia (Muhl. ex Willd) A. Gray, 1997 B.L. Isaac and J.A. Isaac 9615

Dryopteris marginalis (L.) A. Gray, 1998 B.L. Isaac and J.A. Isaac 11659

Dryopteris x boottii (Tuckerman) Underwood (pro sp.), 1955 L.K. Henry s.n.

Dryopteris x neowherryi W.H. Wagner, 1899 J.A. Shafer s.n.

Dryopteris x slossoniae Wherry ex Lellinger, 1909 L.S. Hopkins s.n.

Dryopteris x triploidea Wherry, 2001 B.L. Isaac and J. Isaac and C. Chuey and S. Grund 13592

Dryopteris x uliginosa (A. Braun ex Dowell) Druce, 1946 O.E. Jennings s.n.

Gymnocarpium dryopteris (L.) Newman, 1945 W.E. Buker s.n.

Matteuccia struthiopteris (L.) Todaro, 1963 A.J. Cirucci s.n.

Onoclea sensibilis L., 1998 K. McGowan and M. Scanlon 297

Polystichum acrostichoides (Michx.) Schott, 1998 K. McGowan and M. Scanlon 215

Woodsia obtusa (Spreng.) Torr. ssp. *obtusa*, 2001 J.A. Isaac 13540

Ophioglossaceae

Botrychium dissectum Spreng., 1998 S.A. Thompson and B.L. Isaac and J.A. Isaac 15189

Botrychium matricariifolium (A. Braun ex Dowell) A. Braun, 1982 E.G. Allen s.n.

Botrypus virginianus (L.) Holub, 1964 W.D. Loub WP-880 [*Botrychium virginianum* (L.) Sw.]

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Sceptridium oneidense (Gilbert) Holub, 1937 O.E. Jennings s.n. [*Botrychium oneidense* (Gilbert) House]

Osmundaceae

Osmunda cinnamomea L., 1991 G.H. Pollack 47

Osmunda claytoniana L., 1955 L.K. Henry s.n.

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray, 1946 W.E. Buker and M. Henrici s.n.

Polypodiaceae

Polypodium appalachianum Haufler & Windham, 1940 R.W. Little s.n.

Polypodium virginianum L., 1945 W.E. Buker s.n.

Pteridaceae

Adiantum aleuticum (Rupr.) Paris, 1998 B.L. Isaac and J.A. Isaac 11667 G5?:SNR [*Adiantum pedatum* L.]

Adiantum pedatum L., 1963 A.J. Cirucci s.n.

Thelypteridaceae

Phegopteris hexagonoptera (Michx.) Fee, 1998 B.L. Isaac and J.A. Isaac 11668 [*Thelypteris hexagonoptera* (Michx.) Weatherby]

Thelypteris noveboracensis (L.) Nieuwl., 1998 B.L. Isaac and J.A. Isaac 11670

Thelypteris palustris Schott var. *pubescens* (Lawson) Fern., 1922 O.E. Jennings s.n.

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BOOK REVIEW

Walt Davis and Isabel Davis. 2010. **Exploring the Edges of Texas.** (ISBN 978-1-60344-153-7, hbk.). Texas A & M University Press, Lewis Street, Lindsey Building, 4354 TAMU, College Station, Texas 77843-4354, U.S.A. (**Orders:** www.tamupress.com, 1-800-826-8911, 1-888-617-2421 fax). $24.95. 280 pp., 6 1/4" × 8 3/4".

As inviting as it is, the title conveys only a small portion of this book's contents. True, it touches the edges of Texas, from the Canadian River of the Panhandle to the Guadalupes, to the Rio Grande's turn in the big bend, to Houston's bayous, and to the Sulphur River of Northeast Texas before returning along the Red River to complete the circuit of the state.

Walt Davis, former director of the Panhandle-Plains Historical Museum in Canyon, Texas, and his wife Isabel, a retired librarian, set out to explore regions which have had little press in popular literature. Their interests are in natural history and cultural history, so that along their travels they experience the flora and fauna, the geography and geology of the state with some important explorers of the past as well as with some contemporary personages. Among these are botanists Charles Wright, Jean-Paul Berlandier, and Benito Trevino and naturalists such as Louis Agassiz Fuertes, geologist Jacob Boll, and "bird-lady" Connie Hager—to mention only a few.

There is mystery in the "singular object" (a meteorite) of East Texas. There are concerns that the magnolias are gone from the Houston bayou, that the long-leaf pines are disappearing, that an archeological site that could have yielded much information about prehistoric peoples has been destroyed. There is hope as well, in the production of new groves of those pines, in the work that organizations such as the Texas Archeological Society as well as governmental units are doing in exploration and preservation.

Although the Davises relied heavily on Samuel Geiser's *Naturalists of the Frontier* and on David Schmidly's *Texas Natural History: a Century of Change* as sources, they also delved into many other publications and websites to corroborate and illustrate their texts. With these historical backgrounds and current anecdotes, the book is not only informative but a pleasure to read. The book jacket features a lovely illustration by Walt Davis, while each chapter is prefaced with one of his black and white drawings of the region.—*Joann Karges, Texas Christian University Library (Retired), Fort Worth, Texas, U.S.A.*

NEW VASCULAR PLANT RECORDS FOR SOUTH DAKOTA

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ABSTRACT

Twelve vascular plant taxa new to South Dakota are reported for the first time. Three of the species are exotic and recently adventive to the state whereas the remainder are native to the region and have simply not been previously documented for South Dakota. Citation of voucher specimens and regional geographical accounts are provided for each species.

RESUMEN

Se citan doce nuevos taxa de plantas vasculares de Dakota del Sur. Tres de las especies encontradas son exóticas y llegadas recientemente a Dakota del Sur, mientras que el resto son naturales de la región y no han sido documentadas anteriormente. Se hacen citas de especímenes testigo y se aportan descripciones regionales geográficas para mostrar la procedencia de cada especie.

Key Words: Vascular plants, South Dakota, flora

Field and herbarium research conducted at South Dakota State University have led to the discovery of twelve vascular plant taxa not previously recorded for the state. These are species omitted from prior treatments covering the South Dakota flora either entirely or in part, including Saunders (1899), Over (1932), Rydberg (1932), Dorn (1977), Great Plains Flora Association (1986), and Van Bruggen (1996). Publication of these new records serves to update distributional accounts of these species, such as those provided by the USDA NRCS PLANTS Database (http://plants.usda.gov/), and is intended to augment general knowledge of South Dakota's vascular flora. Voucher specimens documenting these findings are deposited in the C. A. Taylor Herbarium at South Dakota State University (SDC), with duplicates traded to other regional herbaria, including North Dakota State University (NDC), the Rocky Mountain Herbarium (RM), and the University of Kansas (KANU). The newly discovered taxa for South Dakota and their documentation are as follows:

Apera interrupta (L.) P. Beauv. (Poaceae), dense silkybent. *Apera interrupta* is an annual grass introduced from Europe that typically occurs in disturbed habitats. It is naturalized in all states west of the Great Plains and in British Columbia (USDA NRCS 1999) and has otherwise been recorded at scattered locations in eastern North America. Barkworth et al. (2007) describe the grass as "a weed in lawns, grain fields (especially winter wheat), sandy open ground, and roadsides." The South Dakota record is likely attributable to introduction as a contaminant in grass seed since it occurred in a recently planted area of the abandoned Gilt Edge Gold Mine in the northern Black Hills. The Black Hills State University Herbarium Database (2009) includes two records of this species from Crook Co., WY, and thus a South Dakota occurrence is not unexpected and represents an eastward extension of its range.

Voucher specimen: **SOUTH DAKOTA. Lawrence Co.:** 44.33°, -103.66°, uncommon on east-facing slope of waste rock repository cap, second season after seeding, 28 Jun 2005, *Gary E. Larson 11268*.

Azolla mexicana Presl (Azollaceae), Mexican mosquitofern. This is a small, surface-floating aquatic fern that propagates vegetatively to form floating mats much like common duckweed. This species is otherwise known from Nebraska and Minnesota, and so this record represents a northward and westward extension of its range. It may be introduced into our range on a seasonal basis by migrating waterfowl.

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Voucher specimen: **SOUTH DAKOTA. Aurora Co.:** T 103N, R 65W, Sec. 35, NE ¼; floating in shallow marsh on north side of fence dividing a semipermanent wetland, 11 Aug 1997, *Edward S. DeKeyser and Cami Dixon 24.*

Carex leavenworthii Dewey (Cyperaceae), Leavenworth's sedge. According to Kaul et al. (2006), *C. leavenworthii* has been recorded for Cedar County, Nebraska, across the Missouri River from Clay County, South Dakota, and so this occurrence represents a minor northward extension of its range.

Voucher specimen: **SOUTH DAKOTA. Clay Co.:** 42.77°, - 97.12°; Myron Grove, old floodplain forest remnant on Missouri River floodplain, shaded understory; common (*Gary E. Larson 11300*, 19 Jun 2008).

Carex pseudocyperus L. (Cyperaceae), cypresslike sedge. Apparent hybrids with bottlebrush sedge (*C. hystericina* Muhl. *ex* Willd.) were also noted at the collection site. The South Dakota record represents a southward extension of the previously documented range of *C. pseudocyperus.*

Voucher specimen: **SOUTH DAKOTA. Codington Co.:** T 119N, R 51W, Sec. 14, SE ¼; Round Lake Public Access Area; common in flow-through cattail marsh on south side of Round Lake, 6 Sep 2003, *Gary E. Larson and Aquatic Plants class, s.n.*

Galium circaezans Michx. var. **hypomalacum** Fern. (Rubiaceae), woods bedstraw. This finding is a local northward range extension from northern Nebraska where the species is found in woodlands along the Niobrara River and its tributaries (Kaul et al. 2006).

Voucher specimen: **SOUTH DAKOTA. Clay Co.:** 42.77°, - 97.12°; Myron Grove, old floodplain forest on Missouri River floodplain, shaded understory; occasional, 19 Jun 2008, *Gary E. Larson 11298.*

Eriochloa villosa (Thunb.) Kunth (Poaceae), hairy cupgrass. This introduced agricultural weed from East Asia has spread into eastern South Dakota from farther east in the Corn Belt and has become more common and widespread since the original 1983 collection. Northward and westward expansion in the state is expected.

Voucher specimens: **SOUTH DAKOTA. Deuel Co.:** 5 mi NW of Toronto; weed in cultivated field, August 1983, *Leon J. Wrage s.n.* **Minnehaha Co:** 3 mi E, 2 mi N of Garretson in field, 14 July 1986, *Mark Peterson 96.* **Brookings Co.:** South Dakota State Univ. campus; north side of machine storage building at Foundation Seed; disturbed, gravelly soil, 8 Sep 1997, *Gary E. Larson s.n.*

Glaux maritima L. (Primulaceae), sea milkwort. Sea milkwort is otherwise frequent in North Dakota and scattered in western Nebraska where it favors alkaline seeps.

Voucher specimen: **SOUTH DAKOTA. Perkins Co.:** Grand River National Grassland; T 23N, R 11E, Sec. 35, SW ¼; sandstone bank of North Fork of Grand River, sandy textured soil; uncommon, 14 Jun 2002, *Christopher Kopp 207.*

Lechea stricta Leggett *ex* Britton (Cistaceae), prairie pinweed. Prairie pinweed is a psammophilous species found widely scattered in the eastern Nebraska Sand Hills (Kaul et al. 2006) and in Sheyenne National Grasslands of southeastern North Dakota and Bowman County of southwestern North Dakota (Great Plains Flora Association 1977).

Voucher specimens: **SOUTH DAKOTA. Marshall Co.:** T 128N, R 59W, Sec. 6, SE ¼; moderately to heavily grazed sand hills prairie; moist depression with *Poa pratensis, Euthamia gymnospermoides, Antennaria* sp.; rare, 15 Aug 1996, *Gary E. Larson 11686 & Eric Fairlee*, and T 128N, R 59W, Sec. 19, SE ¼; moderately to lightly grazed sand hills prairie; dry sandy sites, temporarily wet in spring; uncommon, 22 Aug 1996, *Gary E. Larson 11767 & Eric Fairlee.*

Lipocarpha micrantha (Vahl) G. Tucker (Cyperaceae), smallflower halfchaff sedge. *Lipocarpha micrantha* (formerly *Hemicarpha m.*) is otherwise known from eastern and central Nebraska and with disjunct records from Cass County, ND and Becker County, MN (Larson 1993).

Voucher specimens: **SOUTH DAKOTA. Brown Co.:** T 128N, R 60W, Sec. 24, NE ¼; sand hill pasture grazed through mid July; choppy sand hills and wet depressions; margin of moist depression, in cow path with *Cyperus squarrosus*; occasional, 16 Aug 1996, *Gary E. Larson 11702 & Eric Fairlee*, and T 127N, R 61W, Sec. 14, SW ¼; level to rolling non-native pasture on loamy fine sand, lightly grazed; locally common in moist or drying soil in shallow depressions, usually where grazed, 22 Jul 1997, *Eric Fairlee 196 & Stacy Severding.*

Monotropa uniflora L. (Monotropaceae), Indianpipe. This nongreen saprophyte has been otherwise found in eastern Nebraska and Ransom County of southeastern North Dakota (Kaul et al. 2006; Great Plains Flora Association 1977). Saunders (1899) reported this species as occurring "in deep, wooded ravines in the Minnesota Valley, Roberts County" of northeastern South Dakota; however, no specimen evidence is known to substantiate Saunders' report, and until now, there were no other accountings of the species in South Dakota.

Voucher specimen: **SOUTH DAKOTA. Minnehaha Co.:** T 101N, R 48W, Sec. 28, SW ¼ of SW ¼; in small grove of bur oak along drainage in horse pasture, just upstream of pond created by a small dam; noted by landowners who were concerned about possibility for plants to poison horses, submitted to Minnehaha County Extension Office for identification, 24 Sep 2008, *Robert and Shirley Phelan s.n.*

Najas minor L. (Najadaceae), brittle waternymph. This is the first record of this invasive annual aquatic plant in South Dakota, and given its history of spread in the eastern U.S. since introduction from Europe in the 1930s (Invasive.org: http://www.invasive.org/species/subject.cfm?sub=3056, accessed Oct. 27, 2009), it is to be expected elsewhere, especially in recreational waters where dispersal by watercraft is likely.

Voucher specimens: **SOUTH DAKOTA. Union Co.:** 42.5378°, -96.5073°; reported as a nuisance plant in shallow to deep water of McCook Lake, mid Aug 2006, *Bruce Johnson and Scott Gerkin s.n.*, collected again from McCook Lake the following year, 19 Jul 2007 by *David J. Ode 07-3.*

Purshia tridentata (Pursh) DC. (Rosaceae), antelope bitterbrush. Dorn (1977) includes *Purshia tridentata* as a species that should occur in the Black Hills but had not been documented there (as indicated by asterisk on the name). Otherwise the shrub is widespread in the mountains of Wyoming and westward. It is apparently uncommon in the western portion of the Black Hills and has simply gone undetected up to this point.

Voucher specimen: **SOUTH DAKOTA. Custer Co.:** 43.5346633°, -103.520889°, adjacent to Song Dog Road and at edge of the Windy Point Fire of 1988, located about 2 m from edge of road, uncommon, 14 Aug 2001, *Chad Lehman 200.*

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PENSTEMON OKLAHOMENSIS (SCROPHULARIACEAE) IN TEXAS

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ABSTRACT

Penstemon oklahomensis is documented as new to the flora of Texas. Included is a key to discriminate the white-flowered *Penstemon* species of northeast Texas.

RESUMEN

Penstemon oklahomensis se documenta como nueva para la flora de Texas. Se incluye una clave para diferenciar las especies de flores blancas de *Penstemon* del nordeste de Texas.

Penstemon Mitchell (Scrophulariaceae) is the most widespread genus of Scrophulariaceae (sensu lato) in North America, with the largest number of documented species (Fernald 1950). At least 270 species (Lodewick & Lodewick 1999; Nold 1999) have been described in North America distributed from Alaska to Guatemala. Freeman (1981) recognized 22 species in the Great Plains, while Clinebell and Bernhardt (1998) suggested that no fewer than 24 species of *Penstemon* are native to the midwestern American prairies from the upper Mississippi Valley southward. Twenty-two species of *Penstemon* are currently recognized in Texas by Turner et al. (2003), with 17 species limited in distribution to the central and western portion of the state.

Recent botanical study in northeast Texas has resulted in the discovery of *Penstemon oklahomensis* Pennell, which is now documented as new to the state.

Voucher specimen: **TEXAS. Lamar Co.:** Gambill Goose Refuge near Crook Lake (Reservoir), ca. 8 mi W of Paris, 5 May 2009, *W.C. Holmes, J.N. Mink & J.R. Singhurst 14514* (BAYLU).

The Gambill Goose Refuge is an area of tallgrass prairie that contains mima mounds, which are important habitat and zonation components of alfisol blackland prairies known to increase biodiversity (Collins 1975; Collins et al. 1975). Characteristic non-woody vegetation of the refuge included *Schizachyrium scoparium*, *S. tenerum*, *Tripsacum dactyloides*, *Tradescantia hirsutiflora*, *Aphanostephus skirrhobasis*, *Asclepias oenotheroides*, *Baptisia bracteata*, *Brickellia eupatoriodes* var. *texana*, *Castilleja purpurea* var. *purpurea*, *Coreopsis tinctoria*, *Croton capitatus*, *Liatris pycnostachya*, *Marshallia caespitosa*, *Penstemon digitalis*, *P. laxiflorus*, *Psoralidium tenuiflorum*, *Ruellia humilis*, *Salvia azurea*, and *Tephrosia virginiana*. The most abundant woody plant in this prairie was *Ceanothus americanus*, while others, such as *Berchemia scandens*, *Cornus drummondii*, *Diospyros virginiana*, *Prunus serotina*, *Juniperus virginiana*, *Rhus copallina* and *Zanthoxylum clava-herculis* were principally limited to marginal areas. Other rare or unusual species were *Calapogon oklahomensis*, *Manfreda virginica* ssp. *lata*, and *Platanthera lacera*.

Penstemon oklahomensis is well-marked by a white corolla with a constricted mouth. The species was considered to be endemic to Oklahoma (Pennell 1935; McGregor & Barkley 1977; McGregor & Barkley 1986). The nearest Oklahoma record of collection is southeast of Bokchito, Bryan County, which is approximately 32 miles northeast of the Lamar County, Texas, record.

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Three other species of *Penstemon* in northeast Texas have white flowers: *P. digitalis* Nutt. *ex* Sims, *P. laxiflorus* Pennell, and *P. tubaeflorus* Nutt. The following key, adapted from Pennell (1935), Correll and Johnston (1970), and Diggs et al. (1999), may be used to distinguish among the four species.

KEY TO THE WHITE-FLOWERED *PENSTEMON* OF NORTHEAST TEXAS

1. Floor of corolla lined internally with reddish or purplish nectar guide streaks.
    2. Corolla 20–25 mm long; nectar guides with pleats evident; staminode prominently exserted and densely bearded with yellow-orange hair _____ **Penstemon laxiflorus**
    2. Corolla 23–30mm long; nectar guides prominently rounded and ventricose; staminode included and lightly bearded with whitish or yellow hair _____ **Penstemon digitalis**
1. Floor of corolla unlined internally.
    3. Corolla 17–23 mm long; tube funnelform to trumpet-shaped from base, the lobes spreading to form an open and prominent orifice; staminode included, lightly bearded with whitish or yellow hair _____ **Penstemon tubaeflorus**
    3. Corolla 25–30mm long; tube narrow at base, abruptly enlarged to the closed orifice (anterior three-lobes upcurve tightly against the united posterior two-lobed lip so as to close orifice of the corolla throat); staminode exserted, densely bearded with deep yellow hairs _____ **Penstemon oklahomensis**

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ANNOTATED CHECKLIST OF THE VASCULAR FLORA OF THE JACK GORE BAYGALL AND NECHES BOTTOM UNITS OF THE BIG THICKET NATIONAL PRESERVE, TYLER, JASPER, AND HARDIN COUNTIES, TEXAS

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ABSTRACT

An annotated, vouchered checklist is provided of the vascular plant taxa of the Jack Gore Baygall and Neches Bottom Units of the Big Thicket National Preserve in Tyler, Jasper, and Hardin counties, Texas. Together they total 5,379 hectares. Documented for the units are 739 taxa (but only 734 species due to multiple varieties in some native species), of which 89 taxa (12.1%) are exotics.

RESUMEN

Se presenta una lista anotada, incluyendo colecciones botánicos, de plantas vasculares en las unidades de Jack Gore Baygall y de Neches Bottom del Big Thicket National Preserve, en los condados de Tyler, Jasper y Hardin en Texas. Juntos estos condados suman 5,379 hectáreas. Se documentan 739 taxones en las unidades (de estas solamente hay 734 especies, esto debido a las múltiples variedades de algunas especies nativas) de los cuales 89 taxones (12,1%) son exóticas.

INTRODUCTION

This is the 8th part of an inventory, based on available voucher specimens, of the vascular flora of the Big Thicket National Preserve in southeastern Texas. In previous papers, we provided annotated checklists of the Hickory Creek, Turkey Creek, Big Sandy Creek, Lance Rosier, Beech Creek, Loblolly, and Menard Creek Units (MacRoberts et al. 2002; Brown et al. 2005, 2006a, 2006b, 2008a, 2008b, 2009). In this paper, we provide an annotated checklist of the Jack Gore Baygall and Neches Bottom Units since they are continuous and occupy the same habitat.

SITE AND METHODS

The Big Thicket National Reserve is located in the West Gulf Coastal Plain in southeastern Texas (see Diggs et al. 2006) for literature and description). It consists of units ranging from 222 to 10,000 hectares and of about 40,100 hectares scattered over seven counties (Fig. 1). The Jack Gore Baygall and Neches Bottom Units straddle the Neches River in Tyler, Jasper, and Hardin counties and total 5,379 hectares (Peacock 1994). Latitude extends from 30°47.933'N at the B.A. Steinhagen Lake dam at Town Bluff south to 30°15.055'N at juncture with the Beaumont Unit. Longitude extends from 94°10.723' at Highway 2937 in Hardin County east to 94°03.660 at Sally Withers Lake in Jasper County. These units are located on Deweyville, Lissie, and modern alluvial soil series (Deshotels 1978; Aranow 1981). The Jack Gore Baygall and Neches Bottom are among the most diverse units in the Preserve in that they contain upper-slope, mid-slope, and lower-slope forests as well as floodplain hardwood forest, wetland baygall, and cypress-tupelo swamp (Harcombe & Marks 1979; Marks & Harcombe 1981).

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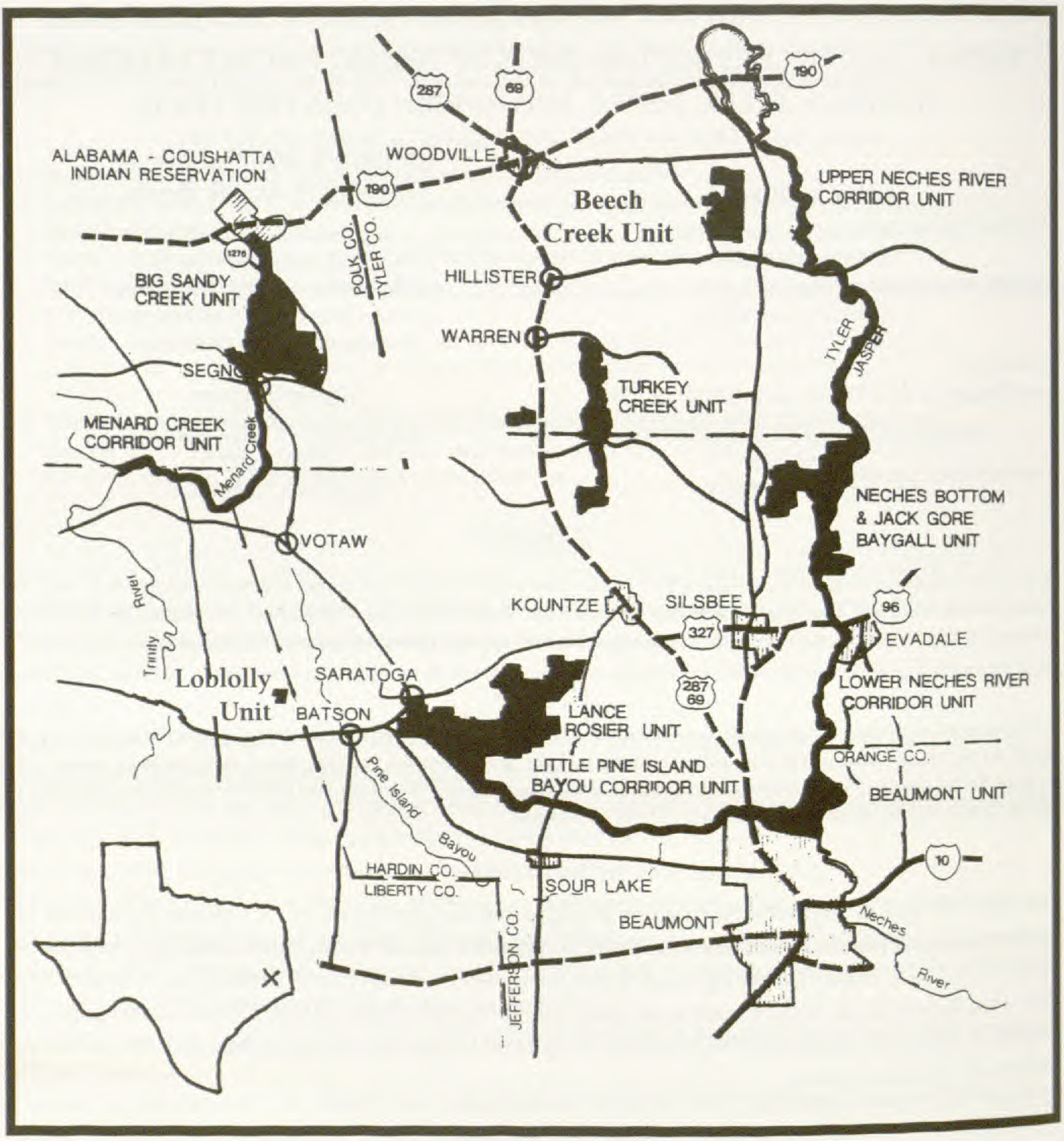
287
69
190
ALABAMA - COUSHATTA INDIAN RESERVATION
WOODVILLE
190
UPPER NECHES RIVER CORRIDOR UNIT
Beech Creek Unit
1276
POLK CO.
TYLER CO.
BIG SANDY CREEK UNIT
HILLISTER
WARREN
TYLER
JASPER
SEGNO
TURKEY CREEK UNIT
MENARD CREEK CORRIDOR UNIT
Menard Creek
NECHES BOTTOM & JACK GORE BAYGALL UNIT
VOTAW
River
Trinity
KOUNTZE
SILSBEE
96
327
EVADALE
Loblolly Unit
SARATOGA
BATSON
287
69
LANCE ROSIER UNIT
LOWER NECHES RIVER CORRIDOR UNIT
ORANGE CO.
LITTLE PINE ISLAND BAYOU CORRIDOR UNIT
BEAUMONT UNIT
Pine Island
Bayou
10
HARDIN CO.
LIBERTY CO.
SOUR LAKE
JEFFERSON CO.
BEAUMONT
Neches
River
X

Fig. 1. Location of the Jack Gore Baygall and Neches Bottom units of the Big Thicket National Preserve, Texas.

Elevation ranges from a high of 33 meters in the small portion of the Jack Gore Baygall Unit adjacent to Highway 2937 to 3 meters at the junction of the Neches River Corridor Unit with the Beaumont Unit.

Like all units of the Big Thicket Biological Preserve, excluding the recent floristic inventories of the above cited units, the Jack Gore Baygall and Neches Bottom units had not previously been the subject of a detailed floristic inventory.

Because our purpose is to produce a list of taxa know to occur in the Jack Gore Baygall and Neches Bottom units, a vouchered specimen was considered to be the only evidence acceptable for inclusion in the list. In all, 1304 + herbarium specimens form the data for this report. Larry Brown annotated all specimens.

Larry Brown collected 716 specimens during 25 field days beginning in June 2008 and ending in November 2009. Stanley Jones collected 338 specimens in the mid 2000s. Geraldine Watson collected 51 specimens over several years in the late 1970s and early 1980s. The MacRoberts collected 31specimens. Sandra Elsik and Warren Pruess together collected 105 specimens and Warren Pruess singly collected 57 specimens. Collection totals for the few others are 12. All collectors and collection numbers are designated by appropriate abbreviations below.

In most cases, the current family nomenclature follows Chester et al. (2009) and A.S. Weakley (2007). Species nomenclature for the most part follows Jones et al. (1997), Kartesz (1999), and Diggs et al. (2006). In cases of multiple collections, no more than four are listed for each taxon.

RESULTS

The following is an annotated list of the Jack Gore Baygall Unit and Neches Bottom Units taxa. Abbreviations used are given below:

CL = C. Liu. His one collection is at TAES.
PH = Paul Harcombe. His one collection is at TAES.
PR = Paul Roling. His specimens are at TAES.
GW = Geraldine Watson. Her specimens are at TAES.
JL = Joe Liggio. He collected with LB and those specimens are at TAES.
SJ = Stanley Jones. His specimens are at TAES.
LB = Larry Brown. His specimens are at TAES, except for the few that are at SBSC indicated by (SBSC) after a collection number.
MM = Barbara and Michael MacRoberts. Their specimens are at TAES.
SH = Shawn Harper (Grandson of LB).
SM = Sam Harper (Grandson of LB).
SE = Sandra Elsik. Her specimens are at TAES.
WP = Warren Pruess. His specimens are at TAES.
EK = Eric Keith. His one collection is at TAES.
RH = Roland Harper (Grandson of LB).
DK = Dale Kruse. His one collection is at TAES.
NIX= Elray Nixon. His collections are at ASTC with some duplicates at SBSC.
WRC= Bill Carr. His collections are at TX.
* = exotic
+ = see note at end of list

A collection number followed by (J) is from Jasper County and a collection number followed by (T) is from Tyler County. All others are from Hardin County.

Acanthaceae
Justicia ovata (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, WP 144
Ruellia caroliniensis (J.F. Gmel.) Steud., SJ 14204; LB 34575
Ruellia humilis Nutt., GW 2953; LBRH 34645
Ruellia pedunculata Torr. ex A. Gray, LB 34606

Aceraceae (see Sapindaceae)

Adoxaceae
Sambucus nigra L. subsp. *canadensis* (L.) Bollii, SJ 14306
Viburnum acerifolium L., SJ 14619
Viburnum dentatum L., SJ 14132; LBRH 33905
Viburnum nudum L. var. *nudum*, SEWP 460; LB 35106

Agavaceae
Yucca louisianensis Trel, LB 34235

Alismataceae
Echinodorus cordifolius (L.) Griseb., SJ 14288; LBSH 34723
Sagittaria latifolia Willd., LBSH 34184
Sagittaria papillosa Buchenau, WP 105
Sagittaria platyphylla (Engelm.) J.G. Smith, LBJL 34018

Alliaceae
Allium canadense L. var. *mobilense* (Regel) Ownbey, LB 34521
Nothoscordum bivalve (L.) Britton, SJ 14429

Altingiaceae
Liquidambar styraciflua L., LBSM 33728

Amaranthaceae
**Alternanthera philoxeroides* (Mart.) Griseb., LBSH 34104
+**Alternanthera sessilis* (L.) R. Br. ex DC., LB 34310
Froelichia floridana SJ 14411
Dysphanis ambrosioides (L.) Mosyakin & Clemants, SJ 14516; LB 35034

Anacardiaceae
Rhus copallinum L., SEWP 222
Toxicodendron pubescens Mill., LB 34595
Toxicodendron radicans (L.) Kuntze, WP 142; SJ 14621
Toxicodendron vernix (L.) Kuntze, LBJL 34036, 34031

Annonaceae
Asimina parviflora (Michx.) Dunal, GW 2948; LBRH 33900; LBSH 34191; LB 34610

Apiaceae (see Araliaceae for *Hydrocotyle*)
Centella erecta (L.f.) Fernald, MM 8012; SEWP 196
Chaerophyllum tainturieri Hook. var. *dasycarpum* Hook. ex S. Watson, LBSH 34393 (J)
**Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & P. Wilson, WP 131
Eryngium prostratum Nutt. ex DC., SEWP 206; LBSH 34713
Limnosciadium pumilum (Engelm. & A. Gray) Mathias & Constance, LB 34577
Ptilimnium capillaceum (Michx.) Raf., SJ 14194a, 14134, 14194; LB 34589
Sanicula canadensis L., WP 136; LBSH 33826
**Torilis nodosa* (L.) Gaertn., LB 34520

Apocynaceae
Asclepias amplexicaulis Michx., SJ 14311
Asclepias obovata Elliott, SEWP 188; GW 2960

Asclepias perennis Walter, SJ 14337; LBSH 34954
+*Gonolobus suberosus* (L.) R.Br, var. *granulatus* (Scheele) Krings & O.Y. Xiang SJ 14146, 14305; LB 34529, 34986
Trachelospermum difforme (Walter) A. Gray, SJ 14340; LB 35088

Aquifoliaceae
Ilex ambigua (Michx.) Torr., SJ 14436, 14422, 14618; LBSH 34942
Ilex coriacea (Pursh) Chapm., WP 161; LB 35104
Ilex decidua Walter, LBSM 33720: LB 34257
Ilex longipes Chapm. ex Trelease, LBRH 33893
Ilex opaca Aiton, WP 156; LB 35075
Ilex vomitoria Aiton, SJ 14502

Araceae
Arisaema triphyllum (L.) Schott., GW 717

Araliaceae
Aralia spinosa L., SJ 14421; LBJL 34028
Hydrocotyle umbellata L., SJ 14366; LB 34211, 34316
Hydrocotyle verticillata Thunb., LB 34527

Aristolochiaceae
Aristolochia reticulata Jacq., SEWP 189
Aristolochia serpentaria L., LB 19218; SJ 14341

Asclepiadaceae (see Apocynaceae)

Aspleniaceae
Asplenium platyneuron (L.) Britton, Sterns & Poggenb., SJ 3217

Asteraceae
Acmella repens (Walter) Rich., SJ 14319; LB 34975
Ambrosia artemisiifolia L., MM 8038; LB 34237
Ambrosia psilostachya DC., LBJL 34010
Ambrosia trifida L., LB 34217
Artemisia ludoviciana Nutt., GW n18
Baccharis halimifolia L., GW 3297; LBJL 34015
Berlandiera pumila (Michx.) Nutt. var. *scabrella* Nesom & B.L. Turner, SJ 14190a; LBSH 33830; LB 34597
+*Bidens aristosa* (Michx.) Britton, SJ 14376; LBRH 34060; LB35071, 35184
Bidens bipinnata L., LBJL 34014
Bidens laevis (L.) Britton, Sterns & Poggenb., LBSH 34097
Boltonia diffusa Elliott, SEWP 191; LB 35068
Bradburia pilosa (Nutt.) Semple, SJ 14418; LB 35019
Chrysopsis mariana (L.) Elliott, SEWP 295; LBRH 33888; LB 34224
Cirsium horridulum Michx., WP 080
Conoclinium coelestinum (L.) DC., MM 8024; SJ 14321
Conyza bonariensis (L.) Cronquist, LB 34159
Conyza canadensis (L.) Cronquist var. *canadensis*, SEWP 213; LBJL 34027
Conyza canadensis (L.) Cronquist var. *pusilla* (Nutt.) Cronquist, SJ 14414
Coreopsis tinctoria Nutt., SJ 14228
Croptilon divaricatum (Nutt.) Raf., SEWP 390; LBRH 33899
Croptilon rigidifolium (E.B. Smith) E.B. Smith, LBSH 34951
Echinacea sanguinea Nutt., SJ 14210
Eclipta prostrata (L.) L., SEWP 311; LBSM 33764
Elephantopus carolinianus Raeusch., MM 8021
Elephantopus nudatus A. Gray, LBSH 34182a; LB 35103
Elephantopus tomentosus L., MM 8011; SJ 14420; LBRH 33885; LBJL 34040
Erechtites hieraciifolia (L.) Raf., MM 8070
Erigeron annuus (L.) C.P. Person, LB 34988
Erigeron philadelphicus L., WP 122; LB 34294
Erigeron strigosus Muhl. ex Willd., SJ 14205; LBJL 34001
Erigeron tenuis Torr. & A. Gray, WP 081
Eupatorium capillifolium (Lam.) Small, LBRH 33884
Eupatorium lancifolium (Torr. & A. Gray) Small, SEWP 220; LBSH 33828; LB 35004
Eupatorium perfoliatum L., LBSM 33765
Eupatorium x pinnatifidum Elliott, WRC 12489; LBRH 34051; LB 35158
Eupatorium rotundifolium L. var. *rotundifolium*, MM 8017; SJ 14500; LBSH 33827
Eupatorium semiserratum DC., LBSM 33757a; LBRH 33909; LBJL 34023; LBSH 34188
Eupatorium serotinum Michx., LBSM 33718a; LB 34217a
Euthamia leptocephala (Torr. & A. Gray) Greene, LB 34519
**Facelis retusa* (Lam.) Sch.-Bip., LB 34615
Gaillardia pulchella Foug., SEWP 197; LB 35100
Gamochaeta antillana (Urb.) Anderb., LB 34306
**Gamochaeta coarctata* (Willd.) Kerguelen, SEWP 456
Gamochaeta purpurea (L.) Cabrera, SJ 14221; LBSH 34411; LB 34540
Gamochaeta pensylvanica (Willd.) Cabrera, LB 34306a
Helenium amarum (Raf.) Rock var. *amarum*, WP 160
Helenium flexuosum Raf., LB 34619
Helianthus angustifolius L., SJ 14378; LB 34220
Heterotheca subaxillaris (Lam.) Britton & Rusby, LBSH 34086
Hieracium gronovii L., GW 2954; LBRH 33906
Hymenopappus artemisiifolius DC., SJ 14281
**Hypochaeris microcephala* (Sch. Bip.) Cabrera, LB 34546
+*Iva asperifolia Less. var. angustifolia* (Nutt. ex DC.) B.L. Turner, SEWP 468; LBJL 33997
Iva annua L., SEWP 467; LBJL 34009
Krigia cespitosa (Raf.) K.L. Chambers var. *cespitosa*, LB 34550
Krigia virginica (L.) Willd., WP 125
Krigia wrightii (A. Gray) K.L. Chambers ex K.J. Kim, LB 34314; LBSH 34396 (J)
Lactuca canadensis L., LBRH 33891
Lactuca floridana (L.) Gaertn., SEWP 309
Liatris acidota Engelm. & A. Gray, SJ 14396
Liatris elegans (Walter) Michx. var. *elegans*, SEWP 280; LB 35005
Liatris squarrosa (L.) Michx. var. *glabrata* (Rydb.) Gaiser, GW 3507, 2975; LBSH 34928, LB 34993
+*Liatris squarrosa* (L.) Michx. var. *squarrosa*, LBSH 34928; LB 34993, 35006
Mikania scandens (L.) Willd. LBSM 33741
Packera obovata (Michx. ex Willd.) Weber & Á. Löve, GW 3323; LB 34278
Pityopsis graminifolia (Michx.) Nutt. SEWP 193; LBSH 34180
Pluchea camphorata (L.) DC., LBSM 33762
Pluchea foetida (L.) DC., MM 8030; SJ 14384; LBJL 34033

+**Pseudognaphalium luteoalbum* (L.) Hillard & B.L. Burtt, LB 34299
Pseudognaphalium obtusifolium (L) Hillard & Burtt, LB 34240,35022
Pyrrhopappus carolinianus (Walter) DC., SJ 14282; GW 2913
Pyrrhopappus pauciflorus DC., LB 34578
Rudbeckia hirta L., SJ 14217; LB 35098
Silphium asteriscus L. var. *asteriscus*, LB 35073
Smallanthus uvedalia (L.) Mack., SEWP 315; LBRH 33894
Solidago altissima L., LBRH 34058
Solidago nitida Torr. & A. Gray, SJ 14361; LB 35070
Solidago odora Aiton, SEWP 279
Solidago rugosa Mill. var. *asper* (Aiton) Fernald, SEWP 304, 297; LBSM 33752; LBRH 34049
Solidago stricta Aiton subsp. *stricta*, SEWP 465; LBSH 34186
**Soliva anthemifolia* Kunth, SJ 14142; LB 34304; LBRH 34642
**Soliva sessilis* Ruiz & Pavon, LB 34534
**Sonchus asper* (L.) Hill, LBRH 34641
**Sonchus oleraceus* L., LBSM 33753; LB 34576
+*Symphyotrichum divaricatum* (Nutt.) G.L. Nesom, LBJL 34042; LBSH 34102; LB 34216
Symphyotrichum dumosum (L.) G.L. Nesom, LBSH 34190; LB 34212, 34215
Symphyotrichum lateriflorum (L.) Á. Löve & D. Löve, LB 34222, 34605, 35116, 35154
Symphyotrichum racemosum (Elliott) G.L. Nesom, WP 135; LBSH 34166
Tetragonotheca ludoviciana (Torr. & A. Gray) A. Gray ex Hall, SJ 14470
Verbesina virginica L., LBRH 34053
+*Vernonia gigantea* (Walter) Trel. ex Banner & Coville, LBSM 33768; LBRH 33887
Vernonia missurica Raf., SJ 26102; LBSH 33842
Vernonia texana (A. Gray) Small, LBSH 33825; LB 34992, 35003
**Youngia japonica* (L.) DC., WP 108; LB 34281
Xanthium strumarium L., LBSH 34964

Balsaminaceae
Impatiens capensis Meerb., PR s.n.; SJ 14144

Berberidaceae
Podophyllum peltatum L., SE 4001

Betulaceae
Betula nigra L., LBSH 34079
Carpinus caroliniana Walter, LBSM 33718; LBSH 34079a; LB 34556
Ostrya virginiana (Mill.) K. Koch, SJ 14131; LBRH 34061

Bignoniaceae
Bignonia capreolata L., WP 072
Campsis radicans (L.) Seem. ex Bureau, LBSH 33833

Blechnaceae
Woodwardia areolata (L.) T. Moore, SJ 14283; LBJL 34034
Woodwardia virginica (L.) J.E.Smith, SEWP 377; LBSH 34410

Boraginaceae
**Heliotropium indicum* L., LBSH 34965
Heliotropium procumbens Mill., SJ 14455; LB 34343
Myosotis macrosperma Engelm., LBSH 34402 (J)

Brassicaceae
**Cardamine flexuosa* With. subsp. *debilis* O.E. Schultz. D. Don, LB 34312
Lepidium virginicum L., SJ 14208
Rorippa palustris Besser, LB 34302
Rorippa sessiliflora (Nutt.) Hitchc., LB 34313; LBSH 34392 (J)

Bromeliaceae
Tillandsia usneoides (L.) L., SJ 14206; LB 34261

Buddlejaceae (see Tetrachondraceae for *Polypremum*)

Burmanniaceae
Apteria aphylla (Nutt.) Barnhart ex Small, SJ 14181a

Cactaceae
Opuntia humifusa (Raf.) Raf., LBSH 33834a; LB 34611

Campanulaceae
Lobelia appendiculata A. DC., LB 34541
Lobelia cardinalis L., LBSH 34174
Lobelia flaccidifolia Small, SJ 14397
Lobelia puberula Michx., SEWP 296; LBRH 34047
Triodanis biflora Greene, LBSH 34398 (J), 34650 (J); LB 34539
Triodanis perfoliata (L.) Nieuwl., GW 3234
**Wahlenbergia marginata* (Thunb.) A. DC., CL s.n., LBSH 33839; LB 34292

Cannabaceae
Celtis laevigata Willd, LBSH 34406 (J)

Caprifoliaceae (see Adoxaceae for *Sambucus* and *Viburnum*)
**Lonicera japonica* Thunb., LBSM 33770

Caryophyllaceae
**Cerastium glomeratum* Thuill., LB 34285
Silene antirrhina L., LBRH 34635

Chenopodiaceae (see Amaranthaceae for *Dysphanis*)

Cistaceae
Helianthemum carolinianum (Walter) Michx., LB 34288
Helianthemum georgianum Chapm., WP 167; LBSH 33837, 34199
Lechea mucronata Raf., SJ 14483, 14189
+*Lechea minor* L., LB 34601, 35011 (SBSC); LBSH 34929

Cleomaceae
**Cleome hassleriana* Chodat, GW 188

Clethraceae
Clethra alnifolia L., LB 19220; SJ 14472, 14431; LBJL 34029

Commelinaceae
Commelina erecta L., SJ 14137, 14185; LB 34604, 34982
Commelina virginica L., SJ 14313, 14524; LB 35079
Tradescantia ohiensis Raf., LB 34315; LBSH 34397 (J)
Tradescantia reverchonii Bush, SJ 14186

Convolvulaceae
Cuscuta compacta Choisy, SEWP 302
Cuscuta gronovii Willd., LB 34207
Dichondra caroliniensis Michx., LBSH 34412
Ipomoea cordatotriloba Dennst., SEWP 277; LBSM 33777

Ipomoea lacunosa L., LB 35090, 35113
Ipomoea pandurata (L.) G. Mey., LBSH 34943
Jacquemontia tamnifolia (L.) Griseb., SEWP 304

Cornaceae (see Nyssaceae for the genus *Nyssa*)
Cornus florida L., SEWP 3005; LB 34289; WP 083 (SBSC)
Cornus foemina Mill., LB 34231

Crassulaceae (see Penthoraceae for the genus *Penthorum*)

Cucurbitaceae
Cayaponia quinqueloba (Raf.) Shinners, SJ 14522; LBSH 34710
**Citrullus vulgaris* Schrad. ex Eckl. & Zeyh., LB 35161
**Cucumis melo* L., LB 35114
Melothria pendula L., LBSM 33736

Cupressaceae
Juniperus virginiana L. var. *virginiana*, LBJL 34005
Taxodium distichum (L.) Rich. var. *distichum*, LBSH 33845

Cuscutaceae (see Convolvulaceae for the genus *Cuscuta*)

Cyperaceae
Bulbostylis barbata (Rottb.) Clarke, SJ 14428
Bulbostylis ciliatifolia (Elliott.) Fernald var. *coarctata* (Elliott) Kral, SJ 14129, 14469; LBRH 33902; LB 35036
Carex abscondita Mack., SJ 14127; LB 34579; LBSH 34648 (J)
Carex atlantica L.H. Bailey subsp. *capillacea* (L H. Bailey) Reznicek, LBJL 33995
Carex brevior (Dewey) Mack. ex Lunell, LBSH 34395 (J); LB 34528
Carex cherokeensis Schwein., LB 34978
Carex complanata Torr. & Hook., LBSH 34413a
Carex debilis Michx., LB 34545
Carex digitalis Schkuhr ex Willd. var. *floridana* (L.H. Bailey) Naczi & Bryson, SJ 14595
Carex flaccosperma Dewey, LBSH 34394 (J); LB 34549
Carex frankii Kunth, LB 34581
Carex gigantea Rudge, SJ 14147
Carex glaucescens Elliott, LBSH 34037
Carex joorii L H. Bailey, NIX 15988; SJ 14473; LBSM 33756
Carex leptalea Wahlenb. subsp. *harperi* (Fernald.) W. Stone, SJ 14145; LBJL 33996
Carex nigromarginata Schwein var. *floridana* (Schwein.) Kük., SJ 13708; LB 34283
Carex reniformis (L.H. Bailey) Small, LB 34536, 34586
Carex tribuloides Wahlenb. var. *sangamonensis* Clokey, SJ 14136
Carex verrucosa Muhl., SEWP 376, 375
Cladium jamaicense Crantz, LBSH 34667
Cyperus acuminatus Torr. & Hook. ex Torr., LB34602
Cyperus compressus L., SJ 14486
Cyperus croceus Vahl, SJ 14487, 145124; LBJL 340342; LBRH 34637
Cyperus elegans L., SEWP 463; LB 35101
**Cyperus entrerianus* Bockeler, LBSM 33743
Cyperus erythrorhizos Muhl., SJ 14440, 14457; LB 35085, 35089
**Cyperus esculentus* L., SJ 14441; LBSH 34163
Cyperus flavescens L., LBRH 34059
Cyperus grayoides Mohlenbr., SJ 14479
Cyperus haspan L., SEWP 369; LBSM 33760
Cyperus hystricinus Fernald, SJ 14471, 14491; LB 34221
**Cyperus iria* L., SJ 14494
Cyperus odoratus Vahl, SJ 14442; LBSH 34078, 34163a, 34970
Cyperus polystachyos Rottb., SJ 14443; LBSH 34162
Cyperus pseudovegetus Steud., SJ 14344; LBSM 33748; LBSH 34960
Cyperus retroflexus Buckley, SJ 14490; LBSH 34958; LB 35016
Cyperus retrorsus Buckley, SJ 14330; LBSM 33740; LBJL 34030
Cyperus squarrosus L., SJ 14451a
Cyperus strigosus L., SJ 14379
Cyperus surinamensis Rottb., SJ 14444; LBSH 34100; LB 35112
Cyperus virens Michx., SJ 14316
Eleocharis microcarpa Torr., MM 8022; LBSH 33831
Eleocharis montana (Kunth) Roem. & Schult., LBSH 34183
Eleocharis obtusa (Willd.) Schult., SJ 14314
Eleocharis tuberculosa (Michx.) Romer & Schult., SEWP 374
Fimbristylis autumnalis (L.) Roem. & Schult., SJ 14446
Fimbristylis dichotoma (L.) Vahl, SJ 14365
**Fimbristylis miliacea* (L.) Vahl, NIX 16005 (SBSC); LB 35031
Fimbristylis vahlii (Lam.) Link, DK 1614; LBSH 34962
Fuirena breviseta (Coville) Coville, SJ 14395
Kyllinga pumila (Torr.) Spreng., SEWP 312; LBSH 33820; LB 34563, 35030
Rhynchospora caduca Elliott, LBRH 34630; LBSH 34664
Rhynchospora colorata (L.) H. Pfeiff., LB 34660
Rhynchospora corniculata (Lam.) A. Gray; MM 8025, SJ 14474, 14318, 14149
Rhynchospora elliottii Elliott, SJ 14390
Rhynchospora globularis (Chapm.) Small var. *globularis*, SEWP 446; LB 34599
Rhynchospora glomerata (L.) Vahl, SJ 14405, 14355; LBJL 34043; LBSH 34938
Rhynchospora grayi Kunth, SJ 14480a, 14480
Rhynchospora inexpansa (Michx.) Vahl, SJ 14404; LBSM 33759
Rhynchospora latifolia (Bald. ex Elliott) Thomas, SJ 14391
Rhynchospora mixta Britton, LB 19218b,19221; SJ 14150
Rhynchospora recognita (Gale) Kral, LBRH 34644; LBSH 34665
Schoenoplectus californicus (Meyer) Sojak, SJ 14153
Scirpus cyperinus L., LBJL 34000
+*Scirpus divaricatus* Elliott, GW 3495; SEWP 320; LBSM 33766; LB 34980
Scleria ciliata Michx. var. ciliata, LB 34600
Scleria oligantha Michx., LB 34552
Scleria pauciflora Muhl. ex Willd., SEWP 294
Scleria triglomerata Michx., SJ 14357

Cyrillaceae
Cyrilla racemiflora L., SJ 14230

Dennstaeditaceae
Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Heller, GW 2953; LBSH 34179

Dioscoreaceae
Dioscorea villosa L., SEWP 314

Droseraceae

Drosera brevifolia Pursh, LB 34596
Drosera capillaris Poir., SJ 14398

Dryopteridaceae (see Woodsiaceae for _Athyrium_ and Onocleaceae for _Onoclea_)

Dryopteris ludoviciana (Kunze) Small, GW 678; SJ 14285; LBJL 34021
Polystichum acrostichoides (Michx.) Schott, LBSM 33751

Ebenaceae

Diospyros virginiana L., LBSM 33725

Equisetaceae

Equisetum hyemale L., GW 3352

Ericaceae

Lyonia ligustrina (L.) DC., SJ 14562
Rhododendron canescens (Michx.) Sweet, SJ 13709; LB 34282
Rhododendron viscosum (L.) Torr., SJ 14289
Vaccinium arboreum Marsh., SJ 14503
Vaccinium corymbosum L., SJ 14358
Vaccinium elliottii Chapm., LB 34296
Vaccinium stamineum L., SEWP 192

Euphorbiaceae (see Phyllanthaceae for _Phyllanthus_)

Acalypha gracilens A. Gray var. _gracilens_, SJ 14413; LB 34991
Acalypha virginica L., LBSH 34167; LB 34233
*_Caperonia palustris_ A. St-Hil., LB 35109
Chamaesyce humistrata (Engelm. ex A. Gray) Small, LBRH 33892
Chamaesyce maculata (L.) Small, LBSH 34192, 34949, 34969
Chamaesyce nutans (Lag.) Small, GW 2951; LB 35062
Chamaesyce serpens (Kunth) Small, LBJL 34016; LBSH 34662
Cnidoscolus texanus (Muell. Arg.) Small, LB 34229
Croton capitatus Michx., MM 8015; SJ 14482
Croton glandulosus L. var. _glandulosus_, SEWP 286; LBSH 34932
Croton michauxii Webster, SJ 14415; LBSH 33838
Croton monanthogynus Michx., SEWP 471; LBJL 34008
Croton willdenowii Webster, SJ 14478; LB 34238, 35029
Euphorbia corollata L., MM 8033; SJ 14220; LB 35152
*_Manihot grahamii_ Hook., GW 446
Sebastiania fruticosa (Bartr.) Fernald, SJ 14126
Stillingia sylvatica L., SJ 14495
Tragia smallii Shinners, LB 34591
Tragia urens L., SJ 14195; LB 35076
Tragia urticifolia Michx., LBRH 33883; LB 35188
*_Triadica sebiferum_ (L.) Small, LBSH 33832

Fabaceae

*_Aeschynomene indica_ L., LB 34209, 35111
*_Albizia julibrissin_ Durazzini, LBSM 33718
Amorpha fruticosa L., LBSH 338411; LBRH 34640; LB 35169
Astragalus leptocarpus Torr. & A. Gray, LB 34297
Centrosema virginianum (L.) Benth., SJ 14184; LBRH 33897
Cercis canadensis L. var. _canadensis_, LB 34561
Chamaecrista fasciculata (Michx.) Greene, SJ 14187
Chamaecrista nictitans (L.) Moench., LBSH 33850
Clitoria mariana L., SJ 14424; LBSM 33727
Crotalaria sagittalis L., SJ 14212, 14483a
Dalea phleoides (Torr. & A. Gray) Shinners var. _phleoides_, GW 2919
Dalea villosa (Nutt.) K. Spreng. var. _grisea_ (Torr. & A. Gray) Barneby, SJ 14209
Desmanthus illinoensis (Michx.) B. L. Rob. & Fernald, SJ 14427
Desmodium ciliare (Willd.) DC., SJ 13967; GW 3313b; LBSH,33824, 34089
+_Desmodium fernaldii_ B.G. Schub., LB 35021
Desmodium glabellum (Michx.) DC., LB 35061
Desmodium laevigatum (Nutt.) DC., LBSH 33840, 34927; LB 35083
Desmodium lineatum DC., LB 35063
Desmodium obtusum (Muhl. ex Willd.) DC., LBSH 34090
Desmodium paniculatum (L.) DC., GW 3416, 2957; LBSM 33735, 33772
+_Desmodium viridiflorum_ (L.) DC., LBSH 33852; LB 35033; LBRH 34065; PR s.n. (T)
Erythrina herbacea L., WP 159
+_Galactia regularis_ (L.) Britton, Sterns, & Poggenb., SJ 14416; LBRH 33901;SEWP 454; LBJL 34017
Gleditsia aquatica Marshall, SJ 14448; LBSH 34400 (J)
Glottidium vesicarium (Jacq.) Harper, SEWP 300; LB 34076
*_Indigofera suffruticosa_ Mill., LBSH 34725
*_Kummerowia striata_ (Thunb. ex Murray) Schindl., LB 34264
+_Lackeya multiflora_ (Torr. & A. Gray) Fortuna, L.P. Queiroz & C.P. Lewis, LBSM 33730; LB 34590; LBRH 34633
Lespedeza hirta (L.) Hornem. subsp. _hirta_, SJ 14199, 14475; LBSH 33836; LB 34236
Lespedeza repens (L.) Bart., LBSM 33737
*_Medicago lupulina_ L., WP 084
Mimosa hystricina (Small) Turner, LB 34543
Mimosa strigillosa Torr. & A. Gray, SJ 14409
Neptunia pubescens Benth., LBSH 34661
*_Pueraria montana_ (Lour.) Merrill var. _lobata_ (Willd.) Van der Maesen & Almeida, SJ 14335
Rhynchosia difformis (Elliott) DC., SJ 14498; LBSH 34722
Rhynchosia latifolia Nutt. ex Torr. & A. Gray, SJ 14123; LB 35018
Rhynchosia reniformis DC., SEWP 285; LB 34557
Senna occidentalis (L.) Link, WP 153
Sesbania drummondii (Rydb.) Cory, LBSH 33846
Sesbania herbacea (Mill.) McVaugh, LBRH 33910
Strophostyles helvola (L.) Elliott, LBSH 34076a
Strophostyles leiosperma (Torr. & A. Gray) Piper, LBSH 34716
Strophostyles umbellata (Willd.) Britton, MM 8037; SEWP 301; GW 3417; LBSH 34935
Stylosanthes biflora (L.) Britton, Sterns & Poggenb., MM 8035; SJ 14218; LB 35008
Tephrosia onobrychoides Nutt., SJ 14383
Tephrosia virginiana (L.) Pers., SJ 14222; LB 34594
*_Trifolium campestre_ Schreb., LB 34298, 34574
*_Trifolium repens_ L., WP 123
Vicia ludoviciana Nutt. subsp. _ludoviciana_, LB 34295
Vicia minutiflora A. Dietr., LB 34256, 34585; LBSH 34405 (J)
Wisteria frutescens (L.) Poir., SJ 14568, 14343

Ipomoea lacunosa L., LB 35090, 35113
Ipomoea pandurata (L.) G. Mey., LBSH 34943
Jacquemontia tamnifolia (L.) Griseb., SEWP 304

Cornaceae (see Nyssaceae for the genus *Nyssa*)
Cornus florida L., SEWP 3005; LB 34289; WP 083 (SBSC)
Cornus foemina Mill., LB 34231

Crassulaceae (see Penthoraceae for the genus *Penthorum*)

Cucurbitaceae
Cayaponia quinqueloba (Raf.) Shinners, SJ 14522; LBSH 34710
**Citrullus vulgaris* Schrad. ex Eckl. & Zeyh., LB 35161
**Cucumis melo* L., LB 35114
Melothria pendula L., LBSM 33736

Cupressaceae
Juniperus virginiana L. var. *virginiana*, LBJL 34005
Taxodium distichum (L.) Rich. var. *distichum*, LBSH 33845

Cuscutaceae (see Convolvulaceae for the genus *Cuscuta*)

Cyperaceae
Bulbostylis barbata (Rottb.) Clarke, SJ 14428
Bulbostylis ciliatifolia (Elliott.) Fernald var. *coarctata* (Elliott) Kral, SJ 14129, 14469; LBRH 33902; LB 35036
Carex abscondita Mack., SJ 14127; LB 34579; LBSH 34648 (J)
Carex atlantica L.H. Bailey subsp. *capillacea* (L H. Bailey) Reznicek, LBJL 33995
Carex brevior (Dewey) Mack. ex Lunell, LBSH 34395 (J); LB 34528
Carex cherokeensis Schwein., LB 34978
Carex complanata Torr. & Hook., LBSH 34413a
Carex debilis Michx., LB 34545
Carex digitalis Schkuhr ex Willd. var. *floridana* (L.H. Bailey) Naczi & Bryson, SJ 14595
Carex flaccosperma Dewey, LBSH 34394 (J); LB 34549
Carex frankii Kunth, LB 34581
Carex gigantea Rudge, SJ 14147
Carex glaucescens Elliott, LBSH 34037
Carex joorii L H. Bailey, NIX 15988; SJ 14473; LBSM 33756
Carex leptalea Wahlenb. subsp. *harperi* (Fernald.) W. Stone, SJ 14145; LBJL 33996
Carex nigromarginata Schwein var. *floridana* (Schwein.) Kük., SJ 13708; LB 34283
Carex reniformis (L.H. Bailey) Small, LB 34536, 34586
Carex tribuloides Wahlenb. var. *sangamonensis* Clokey, SJ 14136
Carex verrucosa Muhl., SEWP 376, 375
Cladium jamaicense Crantz, LBSH 34667
Cyperus acuminatus Torr. & Hook. ex Torr., LB34602
Cyperus compressus L., SJ 14486
Cyperus croceus Vahl, SJ 14487, 145124; LBJL 340342; LBRH 34637
Cyperus elegans L., SEWP 463; LB 35101
**Cyperus entrerianus* Bockeler, LBSM 33743
Cyperus erythrorhizos Muhl., SJ 14440, 14457; LB 35085, 35089
**Cyperus esculentus* L., SJ 14441; LBSH 34163
Cyperus flavescens L., LBRH 34059
Cyperus grayoides Mohlenbr., SJ 14479
Cyperus haspan L., SEWP 369; LBSM 33760
Cyperus hystricinus Fernald, SJ 14471, 14491; LB 34221
**Cyperus iria* L., SJ 14494
Cyperus odoratus Vahl, SJ 14442; LBSH 34078, 34163a, 34970
Cyperus polystachyos Rottb., SJ 14443; LBSH 34162
Cyperus pseudovegetus Steud., SJ 14344; LBSM 33748; LBSH 34960
Cyperus retroflexus Buckley, SJ 14490; LBSH 34958; LB 35016
Cyperus retrorsus Buckley, SJ 14330; LBSM 33740; LBJL 34030
Cyperus squarrosus L., SJ 14451a
Cyperus strigosus L., SJ 14379
Cyperus surinamensis Rottb., SJ 14444; LBSH 34100; LB 35112
Cyperus virens Michx., SJ 14316
Eleocharis microcarpa Torr., MM 8022; LBSH 33831
Eleocharis montana (Kunth) Roem. & Schult., LBSH 34183
Eleocharis obtusa (Willd.) Schult., SJ 14314
Eleocharis tuberculosa (Michx.) Romer & Schult., SEWP 374
Fimbristylis autumnalis (L.) Roem. & Schult., SJ 14446
Fimbristylis dichotoma (L.) Vahl, SJ 14365
**Fimbristylis miliacea* (L.) Vahl, NIX 16005 (SBSC); LB 35031
Fimbristylis vahlii (Lam.) Link, DK 1614; LBSH 34962
Fuirena breviseta (Coville) Coville, SJ 14395
Kyllinga pumila (Torr.) Spreng., SEWP 312; LBSH 33820; LB 34563, 35030
Rhynchospora caduca Elliott, LBRH 34630; LBSH 34664
Rhynchospora colorata (L.) H. Pfeiff., LB 34660
Rhynchospora corniculata (Lam.) A. Gray; MM 8025, SJ 14474, 14318, 14149
Rhynchospora elliottii Elliott, SJ 14390
Rhynchospora globularis (Chapm.) Small var. *globularis*, SEWP 446; LB 34599
Rhynchospora glomerata (L.) Vahl, SJ 14405, 14355; LBJL 34043; LBSH 34938
Rhynchospora grayi Kunth, SJ 14480a, 14480
Rhynchospora inexpansa (Michx.) Vahl, SJ 14404; LBSM 33759
Rhynchospora latifolia (Bald. ex Elliott) Thomas, SJ 14391
Rhynchospora mixta Britton, LB 19218b,19221; SJ 14150
Rhynchospora recognita (Gale) Kral, LBRH 34644; LBSH 34665
Schoenoplectus californicus (Meyer) Sojak, SJ 14153
Scirpus cyperinus L., LBJL 34000
+*Scirpus divaricatus* Elliott, GW 3495; SEWP 320; LBSM 33766; LB 34980
Scleria ciliata Michx. var. ciliata, LB 34600
Scleria oligantha Michx., LB 34552
Scleria pauciflora Muhl. ex Willd., SEWP 294
Scleria triglomerata Michx., SJ 14357

Cyrillaceae
Cyrilla racemiflora L., SJ 14230

Dennstaeditaceae
Pteridium aquilinum (L.) Kuhn var. *pseudocaudatum* (Clute) Heller, GW 2953; LBSH 34179

Dioscoreaceae
Dioscorea villosa L., SEWP 314

Droseraceae
Drosera brevifolia Pursh, LB 34596
Drosera capillaris Poir., SJ 14398

Dryopteridaceae (see Woodsiaceae for _Athyrium_ and Onocleaceae for _Onoclea_)
Dryopteris ludoviciana (Kunze) Small, GW 678; SJ 14285; LBJL 34021
Polystichum acrostichoides (Michx.) Schott, LBSM 33751

Ebenaceae
Diospyros virginiana L., LBSM 33725

Equisetaceae
Equisetum hyemale L., GW 3352

Ericaceae
Lyonia ligustrina (L.) DC., SJ 14562
Rhododendron canescens (Michx.) Sweet, SJ 13709; LB 34282
Rhododendron viscosum (L.) Torr., SJ 14289
Vaccinium arboreum Marsh., SJ 14503
Vaccinium corymbosum L., SJ 14358
Vaccinium elliottii Chapm., LB 34296
Vaccinium stamineum L., SEWP 192

Euphorbiaceae (see Phyllanthaceae for _Phyllanthus_)
Acalypha gracilens A. Gray var. _gracilens_, SJ 14413; LB 34991
Acalypha virginica L., LBSH 34167; LB 34233
*_Caperonia palustris_ A. St-Hil., LB 35109
Chamaesyce humistrata (Engelm. ex A. Gray) Small, LBRH 33892
Chamaesyce maculata (L.) Small, LBSH 34192, 34949, 34969
Chamaesyce nutans (Lag.) Small, GW 2951; LB 35062
Chamaesyce serpens (Kunth) Small, LBJL 34016; LBSH 34662
Cnidoscolus texanus (Muell. Arg.) Small, LB 34229
Croton capitatus Michx., MM 8015; SJ 14482
Croton glandulosus L. var. _glandulosus_, SEWP 286; LBSH 34932
Croton michauxii Webster, SJ 14415; LBSH 33838
Croton monanthogynus Michx., SEWP 471; LBJL 34008
Croton willdenowii Webster, SJ 14478; LB 34238, 35029
Euphorbia corollata L., MM 8033; SJ 14220; LB 35152
*_Manihot grahamii_ Hook., GW 446
Sebastiania fruticosa (Bartr.) Fernald, SJ 14126
Stillingia sylvatica L., SJ 14495
Tragia smallii Shinners, LB 34591
Tragia urens L., SJ 14195; LB 35076
Tragia urticifolia Michx., LBRH 33883; LB 35188
*_Triadica sebiferum_ (L.) Small, LBSH 33832

Fabaceae
*_Aeschynomene indica_ L., LB 34209, 35111
*_Albizia julibrissin_ Durazzini, LBSM 33718
Amorpha fruticosa L., LBSH 338411; LBRH 34640; LB 35169
Astragalus leptocarpus Torr. & A. Gray, LB 34297
Centrosema virginianum (L.) Benth., SJ 14184; LBRH 33897
Cercis canadensis L. var. _canadensis_, LB 34561
Chamaecrista fasciculata (Michx.) Greene, SJ 14187
Chamaecrista nictitans (L.) Moench., LBSH 33850
Clitoria mariana L., SJ 14424; LBSM 33727
Crotalaria sagittalis L., SJ 14212, 14483a
Dalea phleoides (Torr. & A. Gray) Shinners var. _phleoides_, GW 2919
Dalea villosa (Nutt.) K. Spreng. var. _grisea_ (Torr. & A. Gray) Barneby, SJ 14209
Desmanthus illinoensis (Michx.) B. L. Rob. & Fernald, SJ 14427
Desmodium ciliare (Willd.) DC., SJ 13967; GW 3313b; LBSH,33824, 34089
+_Desmodium fernaldii_ B.G. Schub., LB 35021
Desmodium glabellum (Michx.) DC., LB 35061
Desmodium laevigatum (Nutt.) DC., LBSH 33840, 34927; LB 35083
Desmodium lineatum DC., LB 35063
Desmodium obtusum (Muhl. ex Willd.) DC., LBSH 34090
Desmodium paniculatum (L.) DC., GW 3416, 2957; LBSM 33735, 33772
+_Desmodium viridiflorum_ (L.) DC., LBSH 33852; LB 35033; LBRH 34065; PR s.n. (T)
Erythrina herbacea L., WP 159
+_Galactia regularis_ (L.) Britton, Sterns, & Poggenb., SJ 14416; LBRH 33901;SEWP 454; LBJL 34017
Gleditsia aquatica Marshall, SJ 14448; LBSH 34400 (J)
Glottidium vesicarium (Jacq.) Harper, SEWP 300; LB 34076
*_Indigofera suffruticosa_ Mill., LBSH 34725
*_Kummerowia striata_ (Thunb. ex Murray) Schindl., LB 34264
+_Lackeya multiflora_ (Torr. & A. Gray) Fortuna, L.P. Queiroz & C.P. Lewis, LBSM 33730; LB 34590; LBRH 34633
Lespedeza hirta (L.) Hornem. subsp. _hirta_, SJ 14199, 14475; LBSH 33836; LB 34236
Lespedeza repens (L.) Bart., LBSM 33737
*_Medicago lupulina_ L., WP 084
Mimosa hystricina (Small) Turner, LB 34543
Mimosa strigillosa Torr. & A. Gray, SJ 14409
Neptunia pubescens Benth., LBSH 34661
*_Pueraria montana_ (Lour.) Merrill var. _lobata_ (Willd.) Van der Maesen & Almeida, SJ 14335
Rhynchosia difformis (Elliott) DC., SJ 14498; LBSH 34722
Rhynchosia latifolia Nutt. ex Torr. & A. Gray, SJ 14123; LB 35018
Rhynchosia reniformis DC., SEWP 285; LB 34557
Senna occidentalis (L.) Link, WP 153
Sesbania drummondii (Rydb.) Cory, LBSH 33846
Sesbania herbacea (Mill.) McVaugh, LBRH 33910
Strophostyles helvola (L.) Elliott, LBSH 34076a
Strophostyles leiosperma (Torr. & A. Gray) Piper, LBSH 34716
Strophostyles umbellata (Willd.) Britton, MM 8037; SEWP 301; GW 3417; LBSH 34935
Stylosanthes biflora (L.) Britton, Sterns & Poggenb., MM 8035; SJ 14218; LB 35008
Tephrosia onobrychoides Nutt., SJ 14383
Tephrosia virginiana (L.) Pers., SJ 14222; LB 34594
*_Trifolium campestre_ Schreb., LB 34298, 34574
*_Trifolium repens_ L., WP 123
Vicia ludoviciana Nutt. subsp. _ludoviciana_, LB 34295
Vicia minutiflora A. Dietr., LB 34256, 34585; LBSH 34405 (J)
Wisteria frutescens (L.) Poir., SJ 14568, 14343

Fagaceae
Castanea pumila (L.) Mill., WP 140; SJ 14329; LB 34989
Fagus grandifolia Ehrh., MM 8036; SJ 13704; LBJL 33024
Quercus alba L., WP 141; LBRH 34052
Quercus falcata Michx., SEWP 199
Quercus hemisphaerica W. Bartram ex Willd., SJ 14331; LBSM 33719
Quercus incana W. Bartram, SJ 14468; LB 34593
Quercus laurifolia Michx., SEWP 319; LBJL 34003; LBSH 34092
Quercus lyrata Walter, WP 151; LBSM 33722
Quercus margaretta (Ashe) Ashe, SJ 14139; LBSH 34073
Quercus michauxii Nutt., WP 146
Quercus nigra L., WP 152
Quercus velutina Lam., LB 34243
Quercus virginiana Mill., SJ 14504, 14327

Gelsemiaceae
Gelsemium sempervirens (L.) Aiton f., SEWP 3015

Gentianaceae
**Centaurium pulchellum* (Sw.) Druce, WP 075; LB 34562
Sabatia angularis (L.) Pursh, SJ 14388
Sabatia campestris Nutt., LB 34559

Geraniaceae
Geranium carolinianum L., WP 079

Grossulariaceae (see Iteaceae for *Itea*)

Haloragaceae
Proserpinaca palustris L., SJ 14181

Hamamelidaceae (see Altingiaceae for *Liquidambar*)
Hamamelis virginiana L., SJ 14433; LB 35013

Hydrocharitaceae
Limnobium spongia (Bosc.) Rich. ex Steud., LB 35170

Hydroleaceae
Hydrolea ovata Nutt., MM 8014; SJ 14374
Hydrolea uniflora Raf., LB 34981

Hydrophyllaceae (see Hydroleaceae)

Hypericaceae
Hypericum densiflorum Pursh, SJ 14438
Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray, LBRH 33881; LB 35007a
Hypericum galioides Lam., SJ 14375; LBSH 34936
Hypericum gentianoides (L.) Britton, Sterns & Poggenb., LBSH 33848; LB 35007
Hypericum gymnanthum Engelm. & A. Gray, SJ 14214; GW 160
Hypericum hypericoides (L.) Crantz, MM 8027
Hypericum mutilum L., LBSM 33754
Triadenum walteri (J. G. Gmel.) Gleason, SJ 14403
Triadenum tubulosum (Walter) Gleason, GW 2993; LBSH 34646 (J); LB 34985, 35168

Hypoxidaceae
Hypoxis curtissii Rose, SJ 14345; LB 34219
Hypoxis wrightii (Baker) Brackett, WP 073; LB 35077

Iridaceae
Alophia drummondii (Graham) Foster, LBSM 33771; SJ 14188
Sisyrinchium atlanticum E.P. Bicknell, LB 34566
Sisyrinchium rosulatum E.P. Bicknell, GW 1035b; LB 34535

Iteaceae
Itea virginica L., WP 137

Juglandaceae
Carya aquatica (Michx. f.) Nutt., LBSH 33844; LBRH 34625; WP 174 (J) at SBSC
Carya cordiformis (Wang.) K. Koch, GW 2950; LBSH 34093, 34649 (J); LB 34580
Carya glabra (Mill.) Sweet, LBSH 34072, 34419
Carya texana Buckley, LBRH 34046
Carya tomentosa (Lam.) Nutt., SJ 14300; LBSH 33817 LBRH 34639

Juncaceae
Juncus acuminatus Michx., LBSM 33746; LB 34565; LBRH 34632
**Juncus capitatus* Weigel, WRC 12488
Juncus coriaceus Mack., SJ 14356
Juncus dichotomus Elliott, LBSH 34663
Juncus diffusissimus Buckley, LBSH 34164, 34707
Juncus effusus L., WP 106
Juncus marginatus Rostk., LB 34609
Juncus repens Michx., LBSM 33757
Juncus tenuis Willd., LB 34308
Juncus validus Coville, SEWP 464

Lamiaceae
Callicarpa americana L., MM 8031; SJ 141
Hyptis alata (Raf.) Shinners, MM 8028; SJ 14426
Lycopus rubellus Moench., MM 8000; SEWP 310; LB 35105
Lycopus virginicus L., LBSH 34189, 34173
Monarda punctata L var. *lasiodonta* A. Gray, SJ 14459a; LBRH 33896
**Perilla frutescens* (L.) Britton, LBSM 33775
Prunella vulgaris L., SJ 14225
Pycnanthemum albescens Torr. & A. Gray, LBSM 33774
Pycnanthemum tenuifolium Schrad., WP 166; SJ 14227, 14351; LBSH 34934
Salvia lyrata L., LBSM 33773; LBJL 34020; LB 34533
Scutellaria elliptica Muhl., LB 34277, 34553
Scutellaria integrifolia L., SEWP 308; LB 34608
Teucrium canadense L., SJ 14138; LBSH 34649 (J)
Trichostema dichotomum L., LBRH 34064
**Vitex negundo* L. var. *intermedia* (P'ei) Moldenke, SJ 14350

Lauraceae
**Cinnamomum camphora* (L.) J. Presl, LB 35182
Persea borbonia (L.) Spreng., LBRH 33898
Persea palustris (Raf.) Sarg., WP 158; LBJL 34041; LB 35107
Sassafras albidum (Nutt.) Nees, SEWP 208

Lentibulariaceae
Utricularia radiata Small, SJ 14429

Linaceae
Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald SJ 14362
Linum striatum Walter, SJ 14211

Linderniaceae
*_Lindernia crustacea_ (L.) F. von Muell., LBSH 33821
Lindernia dubia (L.) Penn., SJ 14342, 14449; LBSH 33821

Loganiaceae (see Gelsemiaceae for _Gelsemium_)
Mitreola petiolata (J. F. Gmel.) Torr. & A. Gray, MM 8016; SJ 14224: LBSM 33764

Lycopodiaceae
Lycopodiella appressa (Chapm.) Cranfill, LB 34279

Lygodiaceae
*_Lygodium japonicum_ (Thunb. ex Murray) Sw., MM 8019; WP 163

Lythraceae
Ammannia x coccinea Rottb., SJ 14452
*_Cuphea carthagenensis_ (Jacq.) J. F. Macbr., WRC 12487; LBRH 33911
Lythrum alatum Pursh var. _lanceolatum_ (Elliott) A. Gray, LBSH 34717
Rotala ramosior (L.) Koehne, LBRH 33912; LB 35119

Magnoliaceae
Magnolia grandiflora L., SEWP 200
Magnolia virginiana L., LBSM 33744; SEWP 214

Malvaceae
Malvaviscus arboreus Dill ex Cav. var. _drummondii_ (Torr. & A. Gray) Schery, LB 35038
Modiola caroliniana (L.) G. Don, LB 34531
Hibiscus laevis All., SJ 14453; LBSH 34172
Hibiscus moscheutos L., subsp. _lasiocarpos_ (Cav.) O.J. Blanchard, SJ 14286
Sida rhombifolia L., SJ 14400, 14517; LBSH 34169
Tilia americana L., LBJL 34035; LB 34547

Melastomataceae
Rhexia mariana L. var. _mariana_, MM 8024; LBSM 33749; SJ 14410, 14338

Meliaceae
*_Melia azedarach_ L., WP 157

Molluginaceae
*_Glinus radiatus_ (Ruiz & Pav.) Rohrbach, SJ 14450; LB 35163
*_Mollugo verticillata_ L., SJ 14407, 14519; LBSH 34957

Moraceae
Morus rubra L., SEWP 210

Myricaceae
Morella caroliniensis Mill., SJ 13705; LB 35102
Morella cerifera (L.) Small, WP 104; LB 34287

Myrsinaceae
*_Anagallis arvensis_ L., WP 077
Lysimachia radicans Hook., LBSM 33729; WRC 11354; LBSH 34654 (J)

Nartheciaceae
Aletris aurea Walter, LBSH 34715

Nyssaceae
Nyssa aquatica L., SEWP 380; LB 35037
Nyssa biflora Walter, SEWP 325; LBJL 33998
Nyssa sylvatica Marsh., SEWP 324; LBJL 34038

Oleaceae
Chionanthus virginicus L., SJ 13713; LB 35012
Forestiera acuminata (Michx.) Poir., LBSH 34081; SJ 13711
Fraxinus americana L., LBSH 34177
Fraxinus caroliniana Mill., SJ 14336; LBSM 33758; LB 35024, 35166
Fraxinus pennsylvanica Marsh., SJ 14620
*_Ligustrum sinense_ Lour., SEWP 205

Onagraceae
Gaura longiflora Spach, GW 2983; LBJL 34011
Ludwigia alternifolia L., LBSM 33734; SJ 14461
Ludwigia decurrens Walter, MM 8013; SJ 14464; LB 35032
Ludwigia glandulosa Walter, LBSM 33748; LBSH 34718: SEWP 224; LB 35153
Ludwigia linearis Walter, MM 8026
Ludwigia octovalvis (Jacq.) P.H. Raven, SJ 14352; LBSH 34098
Ludwigia palustris (L.) Elliott, WP 145
Ludwigia pilosa Walter, SEWP 322; LBJL 34019, 34979
Oenothera biennis L., LBRH 33895
Oenothera laciniata Hill, WP 107
Oenothera speciosa Nutt., LB 34560

Onocleaceae
Onoclea sensibilis L.var. _sensibilis_, LB 34208

Ophioglossaceae
Botrychium biternatum (Savogny) Underwood, GW 835

Orchidaceae
Hexalectris spicata (Walter) Barnhart, LB 19219 (SBSC); GW 3472,3483
Listeria australis Lindl., GW 919
Spiranthes laciniata (Small) Ames, SJ 14152
Spiranthes odorata (Nutt.) Lindl., SEWP 391; LBSH 34170
Spiranthes praecox (Walter) S. Watson, LB 34525

Orobanchaceae
Epifagus virginiana (L.) Bart., WP 130
Agalinis heterophylla (Nutt.) Small ex Britton, SEWP 225
Agalinis purpurea (L.) Penn., SEWP 281; LBSH 34198; LB 35099
Aureolaria flava (L.) Farwell, LBSH 33829

Osmundaceae
Osmunda cinnamomea L., LBJL 34020
Osmunda regalis L. var. _spectabilis_ (Willd.) A. Gray, WP 110; LBSH 34945

Oxalidaceae
+_Oxalis dillenii_ Jacq., SJ 14226
+*_Oxalis debilis_ Kunth (DC.) Lourteig, WP 129
Oxalis violacea L., Brown 35187

Passifloraceae
Passiflora incarnata L., LB 34974, 35183
Passiflora lutea L., LBSM 33776; SJ 14328; LBRH 34627

Penthoraceae
Penthorum sedoides L., SJ 14401, LBSH 34956

Phrymaceae

Mimulus alatus Aiton, LBSH 34952

Phyllanthaceae

Phyllanthus caroliniensis Walter, LBSM 33755
**Phyllanthus urinaria* L., MM 8020

Phytolaccaceae

Phytolacca americana L., LBSM 33750

Pinaceae

Pinus echinata Mill., SEWP 194
**Pinus elliottii* Engelm., LBSH 34088
Pinus palustris Mill., LB 34226
Pinus taeda L., MM 8029; LBSM 33745

Plantaginaceae

Bacopa monnieri (L.) Penn., GW 2938; LBJL 34013
Gratiola brevifolia Raf., LB 34564; LBSH 34940
Mecardonia acuminata (Walter) Small, MM 7972; SEWP 283
Mecardonia procumbens (Mill.) Small, WP 085
Micranthemum umbrosum (J.F. Gmel.) S.F. Blake, SJ 14326
Nuttallanthus canadensis (L.) D.A. Sutton, LB 34290
Nuttallanthus texanus (Scheele) D.A. Sutton, WP 128; GW 3331, 3332
**Plantago major* L., LB 34266
Plantago virginica L., LBSH 34417; LB 34554
Veronica peregrina L. var. *peregrina*, LB 34305
Scoparia dulcis L., MM 8039; SEWP 440

Platanaceae

Platanus occidentalis L., LBSM 33778

Poaceae

Agrostis hyemalis (Walter) Britton, Sterns & Poggenb., LB 34613
Agrostis perennans (Walter) Tuck., LB 34214
Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb., SEWP 448, 458, 367
Andropogon ternarius Michx., SEWP 453; LBSH 34178; LB 35074
Andropogon virginicus L., LBSH 34087
Anthenantia texana R. Kral, LBRH 34057a
Anthenantia villosa (Michx.) P. Beauv., SEWP 293; LBRH 34057b; LB 34225
Aristida lanosa Muhl. ex Elliott, LBSH 34077
Aristida longespica Poir. var. *geniculata* (Raf.) Fernald, LBRH 34056; LB 35155
Aristida longespica Poir. var. *longespica*, LBSH 34075
Aristida purpurascens Poir. var. *purpurascens*, SJ 14492; LBSH 34084; LB 35156
Aristida purpurascens Poir. var. *virgata* (Trin.) Allred, LBSH 34194
Arundinaria gigantea (Walter) Muhl., LB 34656 (J); PR s.n. (T); LB 35081
Axonopus compressus (Sw.) Beauv., LBSH 34933
Axonopus fissifolius (Raddi) Kuhlm., LBSM 33738; LBSH 34401 (J); LB 35001
Axonopus furcatus (Flüggé) Hitchc., LBSH 34168
**Bothriochloa bladhii* (Retz.) S.T. Blake, LB 35094
**Bothriochloa ischaemum* (L.) Keng var. *songarica* (Fish.& Mey) Celarier & Harlan, SEWP 452
**Briza minor* L., LBSH 34414; LB 34538
**Bromus catharticus* Vahl, LB 34583
Cenchrus spinifex Cav., GW 2943
Chasmanthium latifolium (Michx.) H.O. Yates, LBSH 34657 (J)
Chasmanthium laxum (L.) H.O. Yates, SEWP 187
Chasmanthium sessiliflorum (Poir.) H.O. Yates, SJ 14309, 14521
**Cynodon dactylon* (L.) Person, SEWP 457
**Dactyloctenium aegyptium* (L.) P. Beauv., LB 35095
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark var. *aciculare*, LBRH 33903, LBSH 34930
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, SJ 14128; LBSH 34416; LB 34612, 34617
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *densiflorum* (E.L. Rand & Redfield) Gould & C.A. Clark, LB 34260; LBSH 34953
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark, LB 34587a; LBRH 34638; LBSH 34709
Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *longiligulatum* (Nash) Gould & C.A. Clark, LBSM 33726; LBSH 34655 (J)
Dichanthelium boscii (Poir.) Gould & C.A. Clark, SJ 14402, 14301; LBRH 34050; LB 34990
Dichanthelium commutatum (Schult.) Gould, SJ 14308; LBSM 33724; LB 34259, 34522
Dichanthelium dichotomum (L.) Gould subsp. *dichotomum*, LBSH 34647 (J), 34719
Dichanthelium dichotomum (L.) Gould subsp. *nitidum* (Lam.) Freckman & Lelong, LB 35014
Dichanthelium ensifolium (Baldwin ex Elliott) Gould subsp. *ensifolium*, LBSH 34939
Dichanthelium laxiflorum (Lam.) Gould, LBSM 33742
Dichanthelium oligosanthes (Schult.) Gould var. *oligosanthes*, LBRH 33904; LBSH 34415, LB 34603
Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould, LB 34526; LBSH 34726
Dichanthelium ovale (Elliott) Gould subsp. *villosissimum* (Nash) Freckmann & Lelong, LB 34598; LBSH 34724
Dichanthelium polyanthes Mohlenb., SJ 14223
Dichanthelium scoparium (Lam.) Gould, LB 34607
Dichanthelium sphaerocarpon (Elliott) Gould, LBSH 34399 (J); LB 34592
Dichanthelium tenue (Muhl.) Freckman & Lelong, LBSH 33823; LB 34555, 34598a
Dichanthium annulatum (Forsk.) Stapf, LB 35185
Digitaria bicornis (Lam.) Roem. & Schult., LBSH 34099; LB 35160
Digitaria ciliaris (Retz.) Koel., LBSM 33739, 34948; LBRH 34055; LBSH 34961
**Digitaria ischaemum* (Schreb.) Muhl., LBSM 33739a; LBSH 34103a; LB 34239, 35020
Digitaria villosa Walter, LBRH 34063; LBSH 34085
**Digitaria violascens* Link, LBSH 34176
**Echinochloa colonum* (L.) Link, SJ 14493
**Echinochloa crus-galli* (L.) Beauv., GW 3035
Echinochloa walteri (Pursh) Heller, SJ 14439; LBSH 34074; LB 351135

**Eleusine indica* (L.) Gaertn., SJ 14489; LBSH 34094
Elymus virginicus L., LB 34584
Eragrostis elliottii S. Watson, LB 35108
Eragrostis hypnoides (Lam.) Britton, Sterns & Poggenb. SJ14446; LBSH 34972
**Eragrostis japonica* (Thunb.) Trin., SJ 14462, 14458; LBSH 34103, 34867
Eragrostis refracta (Muhl.) Scribn., LBSH 34197, 34971; LB 34223
Eragrostis secundiflora J. Presl subsp. *oxylepis* (Torr.) S.D. Koch, SJ 14465; LBSH 34076
Eragrostis spectabilis (Pursh) Steud., LBSH 34105, 34175; LB 35015
**Eremochloa ophiuroides* (Munro) Hack., SEWP 466; SJ 14364; LB 35064
Eustachys petraea (Sw.) Desv., SEWP 451
+Glyceria striata (Lam.) Hitchc., LB 34544
Gymnopogon ambiguus (Michx.) Britton, Sterns, & Poggenb., SEWP 287
Leersia lenticularis Michx., SEWP 386; LB 35082
Leersia virginica Willd., LB 34206
**Lolium perenne* L., LB 34537
Muhlenbergia capillaris (Lam.) Trin., LB 35067
Muhlenbergia schreberi J.G. Gmel., LB 35186
Oplismenus hirtellus (L.) P. Beauv. subsp *setarius* (Lam.) Mez ex Ekman, SJ 14435; LB 35017
Panicum anceps Michx., LBSH 33819; SJ 14133, 14347
Panicum brachyanthum Steud., SEWP 288
Panicum dichotomiflorum Michx., SJ 14291; LBSH 34161
Panicum gymnocarpon Elliott, SJ 14354; LB 35080
Panicum rigidulum Bosc. ex Nees, SJ 14346, 14324; LB 35086
Panicum verrucosum Muhl., LBRH 34062; LBSH 34196
**Paspalum dilatatum* Poir., LBSH 34721
Paspalum distichum L., LB 35093
Paspalum floridanum Michx., LBJL 34002
Paspalum laeve Michx., LBSH 34932
Paspalum langei (E. Fourn.) Nash, LB 34588, 35002; LBRH 34631
Paspalum lividum Trin., LBSH 34165
**Paspalum notatum* Flüggé, LBSH 33822
Paspalum minus E. Fourn., LBSH 34182
Paspalum plicatulum Michx., GW 2944; LB 34542
Paspalum repens P.J. Bergius, LB 34987, 35087
Paspalum setaceum Michx., SJ 14520
**Paspalum urvillei* Steud., LBSH 33818
Phalaris angusta Nees ex Trin, LB 34263
**Polypogon monspeliensis* (L.) Desf., LBSH 34666
**Phyllostachys aurea* Riv., SJ 14437
Piptochaetium avenaceum (L.) Parodi, SJ 14207
**Poa annua* L., LB 34255
Poa autumnalis Muhl. ex Elliott, LB 34280
Saccharum brevibarbe (Michx.) Pers. var. *brevibarbe*, EK 950
Saccharum baldwinii Spreng., SEWP 371; LB 35028
Saccharum giganteum (Walter) Pers., LBSH 34187
Sacciolepis striata (L.) Nash, SJ 14463
Schizachyrium scoparium (Michx.) Nash var. *divergens* (Hack.) Gould, SEWP 292; GW 3208; LB 35066
**Sorghum halepense* (L.) Pers., LB 34213
Sphenopholis longiflora (Vasey) Hitchc., LBSH 34404 (J); LB 34651(J)
Sphenopholis obtusata (Michx.) Scribn., LB 34524
Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi, SEWP 447
Sporobolus clandestinus (Biehler) Hitchc., LB 35010, 35065, 35157
Sporobolus indicus (L.) R. Br., LBRH 33882
Sporobolus junceus (P. Beauv.) Kunth, SEWP 443; LBRH 34048
Sporobolus silveanus Swallen, SEWP 290
Sporobolus vaginiflorus (Torr. & A. Gray) A.W. Wood, LB 35092
Tridens flavus (L.) A. S. Hitchc. var. *flavus*, SJ 14499
Tridens strictus (Nutt.) Nash, SEWP 438; LBSH 34181
Triplasis purpurea (Walter) Chapm., SJ 14497; LBSH 34091
Urochloa platyphylla (Munro ex C. Wright) R.D. Webster, LB 34210
Vulpia sciurea (Nutt.) Henrard, LBSH 34418; LB 34614

Polygalaceae

Polygala incarnata L., SJ 14485
Polygala leptocaulis Torr. & A. Gray, SEWP 449
Polygala mariana Mill., SEWP 184
Polygala nana (Michx.) DC. SJ 14219, 14484
Polygala polygama L., SJ 14216
Polygala ramosa Elliott, SJ 14399

Polygonaceae

Brunnichia ovata (Walter) Shinners, WP 154; LBSH 34973
Eriogonum longifolium Nutt. var. *longifolium*, SJ 14501
Polygonum densiflorum Meisn., LB 35165
Polygonum hydropiperoides Michx., SJ 14315
**Polygonum lapathifolium* L., LBSH 34101, 34966; LB 34309
Polygonum punctatum Elliott, SEWP 462; LBSH 34082; LB 35110
**Rumex crispus* L., LBRH 34626
Rumex hastatulus Baldw., GW 2940

Polypodiaceae

Pleopeltis polypodioides (L.) E.B. Andrews & Windham var. *michauxiana* (Weath.) E.B. Andrews & Windham, LBSH 34171

Pontederiaceae

**Eichhornia crassipes* (Mart.) Solms, PH 05016 (J)

Potamogetonaceae

Potamogeton pusillus L., SJ 14430

Primulaceae (see Myrsinaceae for *Anagallis* and *Lysimachia* and Theophrastaceae for *Samolus*)

Ranunculaceae

Anemone berlandieri Pritz., GW s.n.
Clematis crispa L., LBSH 34390 (J)
**Ranunculus muricatus* L., LB 34254
Ranunculus pusillus Poir., LB 34301

Rhamnaceae

Berchemia scandens Trel., LBSH 34391 (J); LB 35009
Frangula caroliniana (Walter) A. Gray, LBSM 33769; WP 132

Rosaceae

Agrimonia microcarpa Wallr., GW 680; LBRH 33890

**Cotoneaster* sp., LBSH 34652 (J)
Crataegus marshallii Eggl., SJ 13714
Crataegus opaca Hook. & Arn. ex Hook., SJ 13710; LBRH 34629
Crataegus viridis L., LB 34293
+*Aronia arbutifolia* (L.) Pers. SJ 14287
+**Potentilla indica* (Andrews) T. Wolf, WP 109; LB 34262
Prunus caroliniana (Mill.) Aiton, SEWP 204; LB 35069
Prunus serotina Ehrh., SEWP 303; LB. 35189
Rubus argutus Link, WP 076
Rubus trivialis Michx., SEWP 450

Rubiaceae
Cephalanthus occidentalis L., SJ 14380
Diodia teres Walter, SJ 14213; LBSH 34946
Diodia virginiana L., LBSM 33732; SJ 14229
**Galium aparine* L., LB 34265
Galium pilosum Aiton, SJ 14215
Galium tinctorium L., LB 34307; LBSH 34403 (J)
Galium uniflorum Michx., SEWP 198
Mitchella repens L., WP 124; LB 35151
Oldenlandia boscii (DC.) Chapm., LBRH 34054
Oldenlandia uniflora L., SEWP 381; LBSH 34096, 34941
**Richardia brasiliensis* Gomes, SJ 14417
**Richardia scabra* L., LBRH 33907; LB 35023

Rutaceae
Zanthoxylum clava-herculis L., LBSH 34950

Salicaceae
Salix nigra Nutt., WP 074

Salviniaceae
**Salvinia minima* Baker, LBSH 34080; LB 35118

Sapindaceae
Acer barbatum Michx., SJ 14302; LB 34096
Acer rubrum L., LBSM 33731

Sapotaceae
Sideroxylon lanuginosum Michx. subsp. *oblongifolium* (Nutt.) T.D. Pennington, WP 139; SJ 14333; LBSH 34083

Saururaceae
Saururus cernuus L., LBSH 3384, 34185

Scrophulariaceae (all of our taxa are in the following families: Orobanchaceae (*Agalinis* and *Aureolaria)*; Linderniaceae (*Lindernia*); Phrymaceae (*Mimulus*); Plantaginaceae (*Bacopa, Gratiola, Mecardonia, Micranthemum, Nuttallanthus, Veronica,* and *Scoparia*)

Selaginellaceae
Selaginella apoda (L.) Spreng., PR s.n.

Smilacaceae
Smilax bona-nox L., LBSH 34407 (J), 34653 (J); LB 34984
Smilax glauca Walter, SEWP 217, 207; LBSH 34413
Smilax laurifolia L., LBJL 34005
Smilax pumila Walter, MM 8019; SEWP 278
Smilax rotundifolia L., SEWP 215
Smilax smallii Morong, SEWP 216; LB 34230, 34258; LBSH 34944
Smilax walteri Pursh, SJ 14561; LB 35025

Solanaceae
Physalis heterophylla Nees, LB 34228
Physalis pubescens L., SJ 14451; GW 2956; LBSH 34095
Solanum carolinense L., SJ 14201
Solanum ptycanthum Dun., SJ 14203; LB 35167

Sphenocleaceae
**Sphenoclea zeylandica* Gaertn., LB 34983

Styraceae
Halesia diptera Ellis, LBSM 33723; SJ 14140, 14339
Styrax americana Lam., SJ 14382, 13715; LBSH 33843; LB 34284

Symplocaceae
Symplocos tinctoria (L.) L'Her., LBSM 33763; SJ 13712

Tetrachondraceae
Polypremum procumbens L., SEWP 461, 203; SJ 14197

Thelypteridaceae
Thelypteris kunthii (Desv.) Morton, MM 8032; SJ 14307; GW 829

Theophrastaceae
Samolus valerandi L. subsp. *parviflorus* (Raf.) Hultén, LBRH 34643

Tiliaceae (see Malvaceae for *Tilia*)

Typhaceae
Typha latifolia L., WP 162

Ulmaceae (see Cannabaceae for *Celtis*)
Planera aquatica (Walter) J. F. Gmel., WP 155
Ulmus alata Michx., SEWP 289
Ulmus americana L., SJ 14303

Urticaceae
Boehmeria cylindrica (L.) Sw., LBJL 34037

Valerianaceae
Valerianella radiata (L.) Dufr., WP 082; LB 34551, 34582

Verbenaceae (see Lamiaceae for *Callicarpa* and *Vitex*)
**Glandularia pulchella* (Sweet) Trons., SEWP 190
Phyla lanceolata (Michx.) Small, LB 35162
Phyla nodiflora (L.) Greene, GW 2934
**Verbena brasiliensis* Vell., SJ 14202; GW 2932
Verbena halei Small, GW 2922; LB 34532
**Verbena rigida* Spreng., LBJL 34012
Verbena scabra Vahl, GW 2959; LB 35164

Violaceae
Viola lanceolata L., LB 34291
Viola sororia Willd. var. *missouriensis* (Greene) McKinney, LB 34286
Viola sororia Willd. var. *sororia*, LB 34548
Viola palmata L., LB 34276

Vitaceae
Ampelopsis arborea (L.) Koehne, WP 143; LBRH 33908
Parthenocissus quinquefolia (L.) Planch., SJ 14304
Vitis aestivalis Michx., SEWP 211; LBRH 34636; LB 34616
Vitis cinerea (Engelm.) Engelm. ex Millardet var. *cinerea*, SJ 14460a, 14408

Vitis palmata Vahl, LBSM 33721; LBSH 34708
Vitis rotundifolia Michx., WP 134; LB 34523

Woodsiaceae

Athyrium filix-femina subsp. *asplenioides* (Michx.) Hultén, SEWP 442: LBJL 34039

Xyridaceae

Xyris ambigua Bey. ex Kunth, SJ 14394
Xyris difformis Chapm., var. *difformis*, LB 35026
Xyris jupicai L. Rich., GW 2961b; LBJL 34026
Xyris laxifolia Mart. var. *iridifolia* (Chapm) Karl, SEWP 459; GW 2961a, 2973; LBJL 33999

NOTES

Alternanthera sessilis. Brown and Marcus (1998) first reported this invasive species new to Texas from Liberty County and later it was found in Brazoria County (Brown et al. 2007). It is now known from Hardin County where it was collected on a sandy, drawn-down site along the Neches River.

Gonolobus suberosus var. **granulatus.** The genus *Gonolobus* is recognized as distinct from *Matelea* and *G. suberosus* has priority over *G. gonocarpus*. (Weakley 2007)

Bidens aristosa. We include *Bidens polylepis* under this taxon following Lipscomb and Smith (1977), Smith (1994), and Diggs et al. (1999).

Iva asperifolia var. **angustifolia.** Turner (2009) has combined our common sumpweed (*Iva angustifolia*) with a taxon known from Gulf Coastal Mexico.

Liatris squarrosa var. **squarrosa.** This variety was not mapped in Texas (Nesom 2006). It is distinguished by the pubescent stems and leaves in contrast to the glabrous stems and leaves of variety *glabra*.

Symphyotrichum divaricatum. We are following Nesom (2005) by using the specific rank and not *Symphyotrichum subulatum* var. *ligulatum* the varietal rank. See Nesom (2009) for further information.

Vernonia gigantea. Turner et al. (2003) mapped it only in Montgomery and Polk counties. Our Hardin County collection is apparently a new county record.

Lechea minor. First reported new to Texas from the Lance Rosier Unit (Brown et al. 2007). Only one non-flowering plant was noted in that Unit. In the Jack Gore Baygall and Neches Bottom Units, collections of vegetative and flowering plants are from a small population on an upland sandy soil under a telephone right of way on the north side of the entrance to the Jack Gore Baygall Unit along Timber Slough Road. Currently, Texas collections of this species are only from these two Big Thicket Units.

Scirpus divaricatus. Turner et al. (2003) and Diggs et al. (2006) mapped this sedge only in Hardin County. The first Texas collection was from the Jack Gore Baygall but no location details were provided (Nixon and Ward 1982). Collections made for this study were from two locations in the Jack Gore Baygall. One was collected in a small shallow woodland pool on the north side of Franklin Lake Road at 30°28.00'N; 94°08.4'W. Collections made there were *LBSM 33766* and *LB 34980*. At this location, the plants were common in a ca 0.4 ha. site. The label data on *GW 3495* was Zig Zag Road, however the road sign along Highway 2937 is Youngblood Road. The first author has observed this species in a woodland depression along this road but did not collect it. It is probable that the only Texas collections are from these two sites.

Desmodium fernaldii. Turner et al. (2003) and Jones et al. (1997) did not list for species for Texas. Our single collection, from an arid sandyland at the pipeline right of way along Timber Slough Road, best fits the description and key in Gleason and Cronquist (1991) who reported it in Texas.

Desmodium viridiflorum. We merge *D. nuttallii* with this species following Gleason and Cronquist (1991, page 296).

Galactia regularis. In most floras, this species is called *Galactia volubilis*. As currently understood *G. volubilis* does not occur in Texas. See Ward and Hall (2004).

Lackeya multiflora. This species, formerly named *Dioclea multiflora*, is not mapped in Hardin County

(Turner et al. 2003). This legume vine, bearing rather large leaflets, was common on sandy soil along the Neches River in Hardin County. Our three collections are from sites that we were able to access.

Aronia arbutifolia. When *Aronia* and *Photinia* are combined, *Aronia* has priority because it is older. (Weakley 2007).

Oxalis dillenii. See Nesom (2009a) regarding this name and a significant revision of the other caulescent *Oxalis.*

Oxalis debilis. See Nesom (2009b) regarding this name and a significant revision of the other acaulescent *Oxalis.*

Glyceria striata. Turner et al. (2003) mapped this common species of the more northern states largely in the Edwards Plateau with Lamar and Washington counties the only stations east of the Plateau. The Hardin County station is the most southern and eastern record for Texas. There was a small population along the Wagon Road Trail which is off of a pipeline right of way in the only portion of the Jack Gore Baygall Unit that contacts Highway 2937.

Potentilla indica. Formerly named *Duchesnea indica* (Andrews) Focke, molecular studies indicate it is better placed in *Potentilla* (Erickson et al. 1998).

Pseudognaphalium luteoalbum. The only record east of the Edwards Plateau for this invasive species was Liberty County (Brown et al. 2007). Our Hardin County collection, from a draw-down site along the Neches River, is the second record east of the Plateau.

DISCUSSION

There are 133 families and 379 genera for the 734 (645 native) species and 739 taxa (650 native) recorded for the Jack Gore Baygall and Neches Bottom Units. Seven families: Poaceae (114 taxa), Asteraceae (95 taxa), Cyperaceae (69 taxa), Fabaceae (52 taxa), Euphorbiaceae (21 taxa), Lamiaceae (15 taxa), and Fagaceae (13 taxa) account for 51% of all taxa collected. The genera with 10 or more taxa are *Cyperus* (21 taxa), *Dichanthelium* (19 taxa), *Carex* (17 taxa), *Quercus* (11 taxa), and *Juncus* (10 taxa). As are all floras, our list is incomplete but we believe that we have collected over 90 % of the taxa. Of the eight units inventoried so far, the following 28 taxa were found only in the Jack Gore and Neches Bottom units: *Alternanthera philoxeroides, Torilis nodosa, Bidens laevis, Croptilon rigidifolium, Pseudognaphalium luteoalbum, Solidago stricta, Tetragonotheca ludoviciana, Vernonia gigantea, Scirpus divaricatus, Impatiens capensis, Cucumis melo, Schoenoplectus californicus, Equisetum hyemale, Astragalus leptocarpus, Desmodium fernaldii, Desmodium lineatum, Limnobium spongia, Glinus radiatus, Hexalectris spicata, Spiranthes laciniata, Saccharum brevibarbe* var. *brevibarbe, Sporobolus vaginiflorus, Potamogeton pusillus, Eichhornia crassipes, Potamogeton pusillus, Anemone berlandieri, Richardia brasiliensis,* and *Vitex negundo* var. *intermedia*.

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THE VASCULAR PLANTS OF MOWOTONY PRAIRIE: A SMALL REMNANT COASTAL GRASSLAND IN BRAZORIA COUNTY, TEXAS

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ABSTRACT

A survey of the vascular flora of Mowotony Prairie, a 42 ha Texas coastal grassland remnant, resulted in a checklist of 199 species of vascular plants representing 41 families and 129 genera. The four families with the most species were Poaceae (45), Asteraceae (38), Cyperaceae (30), and Fabaceae (19). Species-rich genera included *Carex* (7 spp.), *Cyperus* (8 spp.), *Juncus* (6 spp.), *Panicum* (5 spp.), and *Paspalum* (6 spp.). Non native species accounted for 2% of the total number of species. The native flora comprised 195 species distributed in 41 families. Forty one native species and one family that do not occur at Nash Prairie were collected at Mowotony Prairie. The native vascular plant taxa from Mowotony Prairie combined with those reported from Nash Prairie provides a documented 63 families and 331 species for remnant grasslands of the Upper Texas Coast. Local dominance of *Sporobolus silveanus* at Mowotony Prairie suggests a more historically widespread distribution of this species.

RESUMEN

Un estudio de la flora vascular de la Mowotony Prairie, con unas 42 ha de resto de la pradera costera de Texas, dio como resultado una lista de 199 especies de plantas vasculares de 41 familias y 129 géneros. Las cuatro familias con más especies fueron Poaceae (45), Asteraceae (38), Cyperaceae (30), y Fabaceae (19). Los géneros más ricos en especies-fueron *Carex* (7 spp.), *Cyperus* (8 spp.), *Juncus* (6 spp.), *Panicum* (5 spp.), y *Paspalum* (6 spp.). Las especies no nativas fueron un 2% del número total de especies. La flora nativa comprende 195 especies distribuidas en 41 familias. Cuarenta y una especies nativas y una familia que no aparecen en la Nash Prairie se colectaron el la Mowotony Prairie. Los taxa de plantas vasculares nativas de la Mowotony Prairie combinadas con las de la Nash Prairie llegan a documentar 63 familias y 331 especies para los restos de pradera de la costa superior de Texas. La dominancia local de *Sporobolus silveanus* en la Mowotony Prairie sugiere una distribución histórica de esta especie mucho más amplia.

I previously reported a species rich flora for Nash Prairie, a 120 ha remnant of undisturbed Texas coastal grassland (Rosen 2007). During the course of that research, I simultaneously surveyed Mowotony Prairie, a smaller but equally rich and unique coastal grassland. Mowotony Prairie is a 42 ha remnant coastal grassland also located on the Kittie Nash Groce (KNG) Ranch in Brazoria County, Texas (N29°16'16.0"W95°40'19.5"; Fig. 1, Fig. 2). Like Nash Prairie, Mowotony Prairie has similar topographic features, disturbance history, management, and use. The purpose of this paper is to provide an annotated checklist of the vascular plants of Mowotony Prairie and add additional taxa to the native flora of Texas coastal grasslands. Nash and Mowotony Prairies and other remnant coastal grasslands are threatened by the expanding Houston Metropolitan Area (Fig. 1).

CHECKLIST

Families are arranged alphabetically, beginning with monocots, and followed by eudicots. Genera, species, and infraspecific names are arranged alphabetically under families and their classification generally follows Jones et al. (1997). *Dichanthelium* (Hitchc. & Chase) Gould is treated seperately from *Panicum* L. Nativity (species native to the United States) is based on Correll and Johnston (1970). Non-native species are indicated by an asterisk (*). Native coastal grassland taxa not reported from Nash Prairie (Rosen 2007) are indicated by a superscript dagger (†). Finally, endemic (with distribution limited to grasslands of the Upper Texas Coast or with the greatest extent of their range occurring therein), rare (of limited range), or regionally rare (seldom occurring or of previously unknown occurrence in grasslands of the Upper Texas Coast) species are

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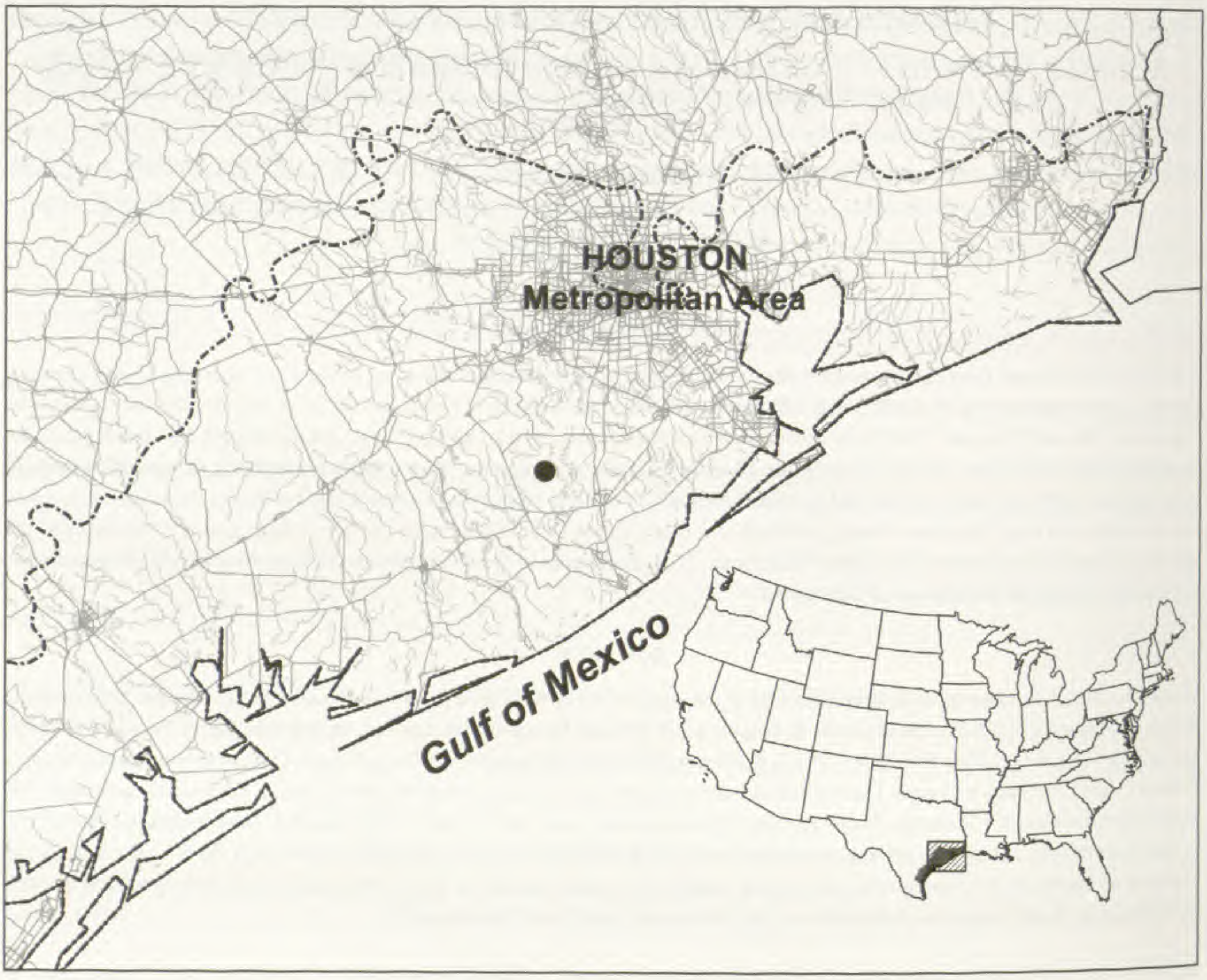


Fig. 1. Location of Kittie Nash Groce (KNG) Ranch (•) and approximate historic boundary of coastal grasslands of the Upper Texas Coast (dash-dotted line).

indicated by a superscript lower case bold **e**, **r**, or **rr** respectively based on review of Correll and Johnston (1970), Turner et al. (2003a; 2003b), or personal experience. A complete set of voucher specimens are housed at the University of Texas at Austin, Plant Resources Center Herbarium (TEX).

MONOCOTS

Alismataceae

Sagittaria graminea Michx. subsp. *graminea*, 3303
Sagittaria papillosa Buchenau, 4138

Alliaceae

Nothoscordum bivalve (L.) Britton, 3279

Amaryllidaceae

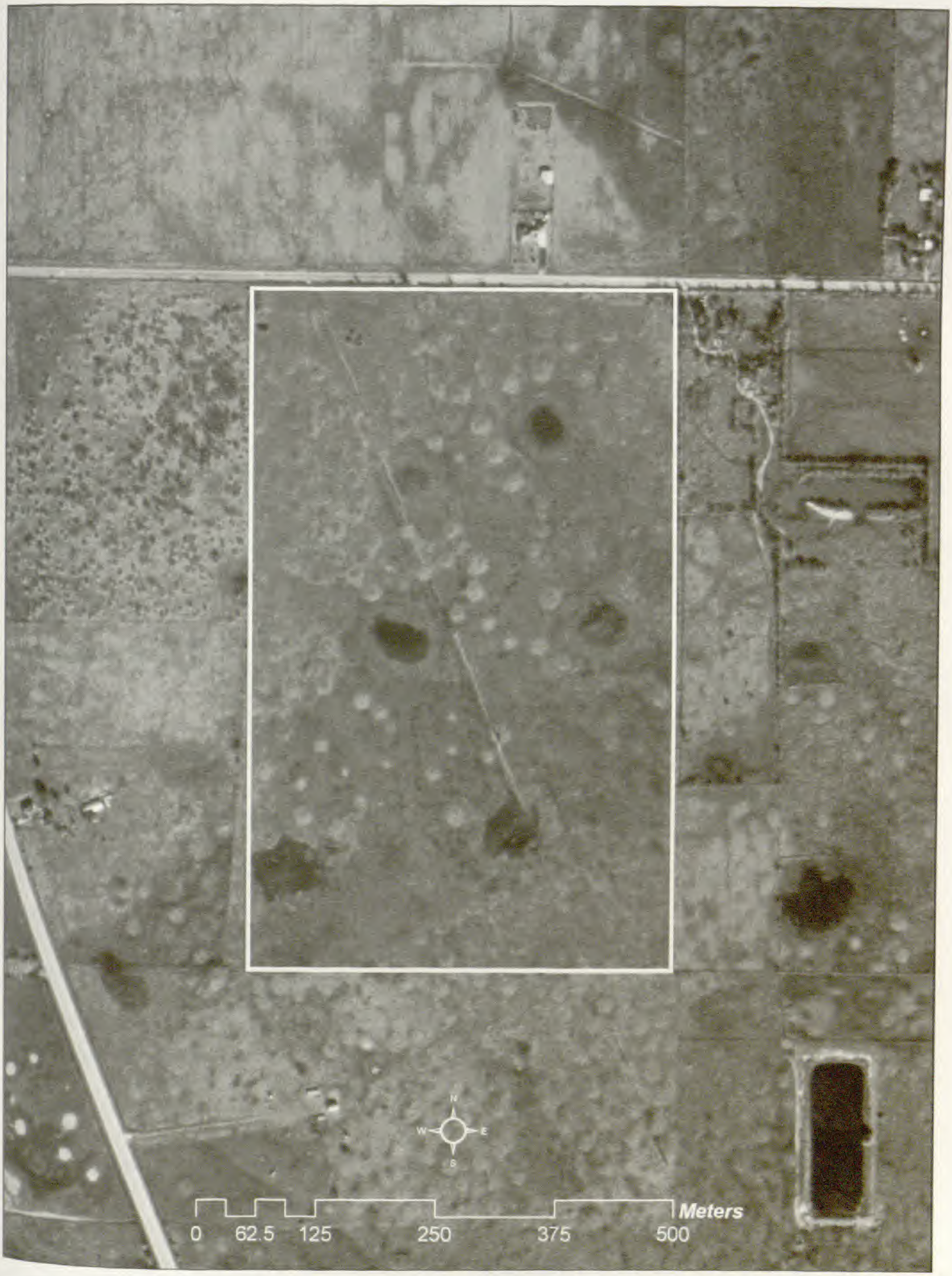
$^{\mathbf{e}}$*Cooperia traubii* W. Hayw., 4382
Hymenocallis liriosme (Raf.) Shinners, 3304

Commelinaceae

†*Tradescantia hirsutiflora* Bush, 4041
†*Tradescantia occidentalis* (Britton) Smyth var. *occidentalis*, 3396

Cyperaceae

Carex bushii Mack., 3328
Carex cherokeënsis Schwein., 3302
Carex festucacea Schkuhr ex Willd., 3321
Carex flaccosperma Dewey, 3301
Carex longii Mack., 3386
Carex meadii Dewey, 3297
Carex triangularis Boeck., 3329
†*Cyperus acuminatus* Torr. & Hook., 4425
Cyperus drummondii Torr. & Hook., 4190
Cyperus echinatus (L.) Alph. Wood, 4189
Cyperus fraternus Kunth, 4151
**Cyperus haspan* L., 4123
Cyperus pseudovegetus Steud. var. *pseudovegetus*, 3377
Cyperus retrorsus Chapm., 4361
Cyperus virens Michx. var. *virens*, 4124
$^{\mathbf{rr}}$*Eleocharis compressa* Sull. var. *acutisquamata* (Buckley) S.G Sm., 3298
Eleocharis microcarpa Torr. var. *filiculmis* Torr., 3322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375
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Meters

FIG. 2. Aerial photograph of Mowotony Prairie (boundary outlined in white), Brazoria County, Texas.

†*Eleocharis montevidensis* Kunth, 3296
Eleocharis quadrangulata (Michx.) Roem. & Schult., 4378
rr*Eleocharis wolfii* (A. Gray) A. Gray ex Britton, 3388
Fimbristylis puberula (Michx.) Vahl var. *puberula*, 3380
†*Isolepis carinata* Hook. & Arn. ex Torr,3295
Rhynchospora caduca Elliott, 3333
Rhynchospora corniculata (Lam.) A. Gray, 4120
Rhynchospora globularis (Chapm.) Small var. *globularis*, 4136
†*Rhynchospora harveyi* W. Boott var. *harveyi*, 4147
Rhynchospora recognita (Gale) Kral, 4572
Scleria ciliata Michx. var. *elliottii* (Chapm.) Fernald, 3332
rr*Scleria muehlenbergii* Steud., 4575
Scleria pauciflora Muhl. ex Willd. var. *pauciflora*, 3330

Hypoxidaceae
Hypoxis hirsuta Coville, 3282

Iridaceae
Herbertia lahue (Molina) Goldblatt, 3399
†*Sisyrinchium ensigerum* E. P. Bicknell, 3281

Juncaceae
Juncus acuminatus Michx., 3379
Juncus brachycarpus Engelm., 3387
†*Juncus dichotomus* S. Elliott, 3344
rr*Juncus elliottii* Chapm. var. *elliottii*, 3385
Juncus marginatus Rostk., 3384
Juncus nodatus Coville, 3383

Orchidaceae
Spiranthes vernalis Engelm. & A. Gray, 3395

Poaceae
Agrostis hyemalis (Walter) Britton, Sterns & Poggenb. var. *hyemalis*, 3271
Andropogon gerardii Vitman subsp. *gerardii*, 4359
†*Andropogon glomeratus* (Walter) Britton, Sterns & Poggenb. var. *pumilus* (Vasey) Vasey ex L.H. Dewey, 4564
Andropogon ternarius Michx. var. *ternarius*, 4577
†*Andropogon virginicus* L. var. *virginicus*, 4571
Aristida purpurascens Poir., 4435
Axonopus fissifolius (Raddi) Kuhlm., 4139
Axonopus furcatus (Flüggé) Hitchc., 4370
r*Bothriochloa exaristata* (Nash) Henrard, 4381
**Briza minor* L., 3288
**Cynodon dactylon* (L.) Pers., 4583
Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark subsp. *aciculare*, 3323
Dichanthelium acuminatum subsp. *acuminatum* (mixed with *D. oligosanthes* (Schult.) Gould subsp. *scribnerianum* (Nash) Freckmann & Lelong), 3319
†*Dichanthelium oligosanthes* (Schult.) Gould subsp. *scribnerianum* (Nash) Freckmann & Lelong (mixed with *D. acuminatum* subsp. *acuminatum*), 3319
†*Dichanthelium portoricense* (Desv. ex Ham.) B.F. Hansen & Wunderlin subsp. *patulum* (Scribn. & Merr.) Freckmann & Lelong, 3284
Dichanthelium sphaerocarpon (Elliott) Gould, 3337
Digitaria cognata (Schult.) Pilg., 4580
Eragrostis lugens Nees, 4434
Eragrostis refracta (Muhl. ex Elliott) Scribn., 4566
Eragrostis spectabilis (Pursh) Steud., 4565
Leersia hexandra Sw., 4141
Muhlenbergia capillaris (Lam.) Trin., 4427
Panicum bergii Arechav., 4187
Panicum dichotomiflorum Michx., 4390
Panicum hemitomon Schult., 4126
†*Panicum rigidulum* Bosc ex Nees subsp. *pubescens* (Vasey) Freckmann & Lelong, 4274
Panicum rigidulum Bosc ex Nees subsp. *rigidulum*, 4371
Paspalum floridanum Michx., 4357
†*Paspalum laeve* Michx., 4433
Paspalum plicatulum Michx., 4122
Paspalum praecox Walter, 4121
Paspalum setaceum Michx. var. *muhlenbergii* (Nash) D.J. Banks, 4358
**Paspalum urvillei* Steud., 4129
Paspalidium geminatum (Forssk.) Stapf var. *geminatum*, 2601
Phalaris angusta Nees ex Trin., 3272
Schizachyrium scoparium (Michx.) Nash var. *scoparium*, 4362
†*Schizachyrium tenerum* Nees, 2600
Setaria parviflora (Poir.) Kerguélen, 4364
Sorghastrum nutans (L.) Nash, 4430
Sphenopholis obtusata (Michx.) Scribn. var. *obtusata*, 3324
Sporobolus compositus (Poir.) Merr. var. *macer* (Trin.) Kartesz & Gandhi, 4363
rr*Sporobolus silveanus* J. Swallen, 2599
Steinchisma hians (Elliott) Nash, 4140
Tridens strictus (Nutt.) Nash, 4389
Vulpia octoflora (T. Walter) P. Rydberg var. *octoflora*, 3327

EUDICOTS

Acanthaceae
Justicia ovata (Walter) Lindau var. *lanceolata* (Chapm.) R.W. Long, 4127
Ruellia humilis Nutt. var. *depauperata* Tharp & F.A. Barkley, 4574
Ruellia nudiflora (Engelm. & A. Gray) Urb. var. *nudiflora*, 4288

Apiaceae
Eryngium yuccifolium Michx., 4272
Hydrocotyle umbellata L., 3378
Limnosciadium pinnatum (DC.) Mathias & Constance, 3342

Apocynaceae (Incl. Asclepiadaceae)
Asclepias longifolia Michx., 4135
Asclepias verticillata L., 4118
Asclepias viridis Walter, 3397

Asteraceae
Acmella oppositifolia (Lam.) R.K. Jansen var. *repens* (Walter) R.K. Jansen, 4369
Ambrosia psilostachya DC., 4396
Ambrosia trifida L., 4424
Arnoglossum plantagineum Raf., 3402
†*Baccharis halimifolia* L., 4569
Boltonia diffusa Elliott var. *diffusa*, 4373
Cirsium horridulum Michx. var. *elliottii* Torr. & A. Gray, 3340
Conoclinium coelestinum (L.) DC., 4568

†*Conyza canadensis* (L.) Cronquist var. *canadensis*, 4386
Coreopsis tinctoria Nutt. var. *tinctoria*, 3389
Erigeron tenuis Torr. & A. Gray, 3317
Eupatorium serotinum Michx., 4397
†*Eurybia hemispherica* (Alexander) G.L. Nesom, 3965
Euthamia gymnospermoides Greene, 4374
Euthamia leptocephala (Torr. & A. Gray) Greene ex Porter & Britton, 4429
Gamochaeta purpurea (L.) Cabrera, 3391
Helenium flexuosum Raf., 3381
Helianthus angustifolius L., 4431
†*Iva angustifolia* Nutt. ex DC., 4578
Iva annua L., 4423
Krigia dandelion (L.) Nutt., 3293
Liatris acidota Engelm. & A. Gray, 4269
†*Packera tampicana* (DC) C. Jeffrey, 3341
†*Parthenium hysterophorus* L., 4586
Pityopsis graminifolia (Michx.) Nutt., 3599
†*Pluchea foetida* (L.) DC., 4375
†*Pyrrhopappus carolinianus* (Walter) DC., 4133
Rudbeckia hirta L. var. *angustifolia* (T.V. Moore) Perdue, 3290
•*Rudbeckia texana* (Perdue) P.B. Cox & Urbatsch, 4289
Silphium radula Nuttall var. *gracile* (A. Gray) J.A. Clevinger, 3291
Solidago altissima L. subsp. *altissima*, 4570
†*Solidago odora* Aiton, 3600
Solidago stricta Aiton, 4573
Solidago tortifolia Elliott, 4360
†*Symphyotrichum divaricatum* (Nutt.) G.L. Nesom, 4584
Symphyotrichum dumosum (L.) G.L. Nesom, 4579
Symphyotrichum pratense (Raf.) G.L. Nesom, 2677
†*Vernonia baldwinii* Torr., 4377

†Buddlejaceae
†*Polypremum procumbens* L., 3394

Campanulaceae
Lobelia puberula Michx., 4143

Clusiaceae
†*Hypericum drummondii* (Grev. & Hook.) Torr. & A. Gray, 4385

Convolvulaceae
Evolvulus sericeus Sw. var. *sericeus*, 4271
Ipomoea cordatotriloba Dennst. var. *cordatotriloba*, 4392

Droseraceae
Drosera brevifolia Pursh, 3294

Euphorbiaceae
Acalypha gracilens A. Gray var. *gracilens*, 4383
Croton capitatus Michx. var. *lindheimeri* (Engelm. & A. Gray) Müll. Arg., 4388
Croton glandulosus L. var. *lindheimeri* Müll. Arg., 4277
†*Croton glandulosus* L. var. *septentrionalis* Müll. Arg., 4387
Euphorbia bicolor Engelm. & A. Gray, 4394
†*Euphorbia maculata* L., 4384

Fabaceae
†*Acacia farnesiana* (L.) C. Willd. var. *farnesiana*, 3339
Baptisia bracteata Muhl. ex Elliott var. *leucophaea* (Nutt.) Kartesz & Gandhi, 3292
Baptisia sphaerocarpa Nutt., 3338
Centrosema virginianum (L.) Benth., 4270
Chamaecrista fasciculata (Michx.) Greene, 4149
Mimosa nuttallii (DC.) B.L. Turner, 3393
†*Mimosa strigillosa* Torr. & A. Gray, 4585
Neptunia lutea (Leavenw.) Benth., 3392
Neptunia pubescens Benth. var. *pubescens*, 4428
Sesbania drummondii (Rydb.) Cory, 4372
†*Strophostyles leiosperma* (Torr. & A. Gray) Piper, 4276
Tephrosia onobrychoides Nutt., 4146
Vicia ludoviciana Nutt. subsp. *ludoviciana*, 3278

Gentianaceae
Sabatia campestris Nutt., 3343

Geraniaceae
Geranium carolinianum L. var. *carolinianum*, 3280

Haloragaceae
Proserpinaca palustris L., 4119

Hydrophyllaceae
Hydrolea ovata Nutt. ex Choisy, 4367

Lamiaceae
Physostegia intermedia (Nutt.) Engelm. & A. Gray, 3382
†*Salvia azurea* Lam. var. *grandiflora* Benth., 4278
Scutellaria parvula Michx. var. *parvula*, 3283

Linaceae
Linum medium (Planch.) Britton var. *texanum* (Planch.) Fernald, 4144

Lythraceae
Lythrum alatum Pursh var. *lanceolatum* (Elliott) Rothr., 4376

Malvaceae
Callirhoë involucrata (Torr. & A. Gray) A. Gray var. *lineariloba* (Torr. & A. Gray) A. Gray, 3398

Melastomataceae
†*Rhexia mariana* L. var. *exalbida* Michx., 4150

Onagraceae
Ludwigia glandulosa Walter, 4137
Ludwigia linearis Walter, 4366
Oenothera laciniata Hill, 3277

Passifloraceae
Passiflora incarnata L., 3400

Plantaginaceae
Plantago virginica L., 3336

Polygalaceae
Polygala incarnata L., 4134

Polygonaceae
Polygonum hydropiperoides Michx., 4368
†*Rumex hastatulus* Baldwin, 3390

Primulaceae
Anagallis minima (L.) E. H. L. Krause, 3276

Ranunculaceae
Ranunculus laxicaulis (Torr. & A. Gray) Darby, 3274
•*Thalictrum texanum* (A. Gray) Small, 3286

Rosaceae

†*Rubus trivialis* Michx., 3275

Rubiaceae

Diodia virginiana L., 4142
Galium tinctorium L., 4043
Houstonia pusilla Schoepf, 3285

Scrophulariaceae

†*Agalinis fasciculata* (Elliott) Raf., 4379
Agalinis viridis (Small) Pennell, 4432
Buchnera americana L., 2598
Castilleja indivisa Engelm., 3289
Mecardonia acuminata (Walter) Small, 4436
†*Nuttallanthus texanus* (Scheele) D. Sutton, 3273

Verbenaceae

†*Phyla incisa* Small, 4042
Verbena halei Small, 3401

Table 1. Taxonomic summary of vascular plants of Mowotony Prairie.

			Species		
	Families	**Genera**	**Native**	**Non-native**	**Total**
Monocots	10	41	88	4	92
Eudicots	31	88	107	0	107
Totals	41	129	195	4	199

This research resulted in collections of 199 species of vascular plants representing 41 families and 129 genera (Table 1). The four families with the most species were Poaceae (45), Asteraceae (38), Cyperaceae (30), and Fabaceae (19). Species-rich genera included *Carex* (7 spp.), *Cyperus* (8 spp.), *Juncus* (6 spp.), *Panicum* (5 spp.), and *Paspalum* (6 spp.). Non native species (*Cyperus haspan*, *Briza minor*, *Cynodon dactylon*, and *Paspalum urvillei*) accounted for 2% of the total number of species.

Of the 195 native species that occur at Mowotony Prairie, 41 are not known from Nash Prairie (Rosen 2007). One family, Buddlejaceae, is not known from Nash Prairie (Rosen 2007). The native vascular plant taxa reported here combined with those reported from Nash Prairie provides a documented 63 families and 331 species for remnant coastal grasslands of the Upper Texas Coast.

Nine endemic, rare, or regionally rare species found at Nash Prairie also occur at Mowotony Prairie: *Cooperia traubii*, *Eleocharis compressa* var. *acutisquamata*, *E. wolfii*, *Scleria muehlenbergii*, *Juncus elliottii* var. *elliottii*, *Bothriochloa exaristata*, *Sporobolus silveanus*, *Rudbeckia texana*, and *Thalictrum texanum*. An additional interesting characteristic of Mowotony Prairie is the local abundance and dominance of uplands by *Sporobolus silveanus*. This species is endemic to the southeastern United States (Louisiana, Oklahoma, Texas) where it grows in blackland prairies, wet to mesic pine woodlands and adjacent glades and barrens (Gould 1975; Flora of North America Editorial Committee 2003). Diamond and Smeins (1985) described a novel *S. silveanus*-*Carex meadii* grassland type from the northern end of the Blackland Prairie region of Texas. This occurrence of seemingly the same or similar community over 500 km south of sites where it was discovered and described by Diamond and Smeins (1985) might indicate that it was more widespread, and much of its original extent has been destroyed.

ACKNOWLEDGMENTS

I am grateful to Larry Brown, Michael Palmer, and Chris Reid for reviewing this manuscript. Robert Freckmann, Robert Kral, and Guy Nesom annotated difficult specimens. Special thanks to Susan and Peter Conaty for the tireless pursuit of a means for permanent conservation of Mowotony and Nash Prairies. Adam Young prepared figure 2.

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BOOK REVIEW

JENNIFER P. MATHEWS. 2009. **Chicle: The Chewing Gum of the Americas, From the Ancient Maya to William Wrigley.** (ISBN 978-0-8165-2821-9, pbk.). The University of Arizona Press, 355 S. Euclid Avenue, Suite 103, Tucson, Arizona 85719, U.S.A. (**Orders:** www.uapress.arizona.edu, 1-800-426-3797). $17.95, 142 pp., b&w photographs and figures, 7" × 8 1/2".

> "Before Dentyne and Chiclets, before bubblegum comic strips and the Doublemint twins, there was gum, oozing from the jungle trees like melting candle wax under the slash of a machete. *Chicle* tells us the spellbinding story of what happened next."—From the back cover

Although the cover design is colorful, bold, and catchy, this is not a book for the casual layperson. Author Jennifer Mathews has produced an academic treatise on all things gum—a heavily detailed, multi-layered research paper on the 11,000 year-old story of chewing gum. With a 9-page opening section (acknowledgments and introduction) and a 50-page closing section (notes, bibliography, and index), the main content is only 88 pages. But with the help of black and white photographs and line drawings sprinkled throughout, this main section is a succinct yet comprehensive reference work covering four main areas: The Birth of the Chewing Gum Tree, The Botany of the Sapodilla Tree, The History of the Chewing Gum Industry in the Americas, and The Chicleros (chicle extractors).

Chapter 1 introduces us to the sapodilla, or chicozapote, tree (*Manilkara zapota*) and the varied uses of its latex, wood, and fruit "across the centuries." The symbolism and social consequences of gum chewing are also discussed relative to different cultures and time periods. For example, in 16th century Aztec society, only women were allowed to chew gum, mostly as a means of oral perfume, and any men caught chewing were viewed as effeminates or sodomites.

Chapter 2 was co-authored by botanist Gillian P. Schultz from Foothill College in California and covers the botanical details of the sapodilla tree, from its taxonomy to its medicinal uses. Chapter 3 walks us through the history of gum, from prehistoric days to Bazooka Joe. It is the longest chapter of the book, covering the rise of the commercial gum trade in the United States and the subsequent demise of the chicle industry. It concludes with the analysis that "today, chicle production has become a boutique industry that caters to consumers instead of natural products."

Chapter 4 tells the story of the *chicleros*, the local laborers/skilled artisans who extract the prized sap or latex from the sapodilla tree. Their story is an interesting one, a tale of misunderstood loners, commercial exploitation, hooliganism, legitimate criminals, and serendipitous discoveries.

Chicle is a great reference, albeit on a very narrow subject. If forced to highlight a point of contention, it would be that the author editorialized a bit in Chapter 3 in her quite obvious backing of one particular gum brand. I don't believe in free advertising for products I know nothing about, so I won't mention the brand name here, but Dr. Mathews had no such reservations. She promoted this specific brand of natural chicle gum, to the exclusion of other brands, and did so when impartial, objective remarks about the natural gum industry as a whole would have had the same impact.—*M. Brooke Byerley, Botanical Research Institute of Texas, 500 E 4th Street, Fort Worth, Texas, 76106-4025 U.S.A.*

THE VASCULAR FLORA OF KERR WILDLIFE MANAGEMENT AREA, KERR COUNTY, TEXAS

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ABSTRACT

An inventory of the vascular plants of Kerr Wildlife Management Area, Kerr County, Texas, was conducted from 2006 to spring 2009. The area consists of 21 natural plant community associations and three land use classes. The Sawgrass-Spikesedge-Beakrush-Black Bogrush-Aparejograss Herbaceous Vegetation Association, and Ashe Juniper-Bastard Oak-Plateau Live Oak Woodland Association is reported as new to the state. The checklist reports 719 taxa from 106 families and 410 genera, with 27 of the species being endemic to the state. The largest families were Asteraceae (113 species), Poaceae (109 species), Fabaceae (38 species), and Euphorbiaceae (34 species). Non-native species comprised 9.04% (65 species) of the flora. Among the more unusual plant records for the area, which consists of a mixture of eastern and western species, are *Rhynchospora capillacea*, *Petrophytum caespitosum*, and *Echeandia flavescens*. Statistics on the adequacy of sampling and a comparative vegetation analysis are also presented.

RESUMEN

Se realizó un inventario de las plantas vasculares del Área de Manejo de Vida Silvestre de Kerr, Condado de Kerr, Tejas, entre 2006 y primavera 2009. Se demostró que el área contiene 21 asociaciones de plantas naturales, y cuatro clases de uso de la tierra. Se citó como nueva para el estado las Asociaciónes de Vegetación Herbácea de Sawgrass-Spikesedge-Beakrush-Black Bogrush-Aparejograss y Ashe Juniper-Bastard Oak-Plateau Live Oak Woodland Asociación. En el catálogo se citan 719 taxones de 106 familias y 410 géneros, con 27 de las especies endémicas del estado. Las familias más grandes fueron Asteraceae (113 especies), Poaceae (109 especies), Fabaceae (38 especies), y Euphorbiaceae (34 especies). Las especies no nativas constituyeron el 9.04% (65 especies) de la flora. Entre las citas más interesantes para el área, que consta de una mezcla de especies orientales y occidentales, están *Rhynchospora capillacea*, *Petrophytum caespitosum*, y *Echeandia flavescens*. Se presentan estadísticas sobre la adecuación del muestreo y un análisis comparado de la vegetación.

Kerr Wildlife Management Area (KWMA) is located in the south central portion of the Edwards Plateau vegetation area (Terletzkey & Van Auken 1996; Van Auken 1988). Geologically, KWMA is characterized by dry and seepy limestone cliffs, canyons with shaded ravines and boulders, outcrops, glades, spring-fed drainages, and the Guadalupe River. Vegetatively, the Edwards Plateau has been described as a region of significant endemism (Correll & Johnston 1970). Carr (2008) lists 88 species as endemic to the region. Additionally, Plateau vegetation is distinctive because of woody eastern species that are present as disjuncts or reach the western limits of their distribution there. These include *Lindera benzoin*, *Bignonia capreolata*, *Hamamelis virginiana*, *Aesculus pavia*, *Ulmus rubra*, *Aristolochia serpentaria*, *Berchemia scandens*, *Morus rubra*, *Tilia americana*, and *Menispermum canadense*. Herbaceous vegetation with a similar distribution pattern, which is generally not discussed in this context, includes *Scleria verticillata*, *Bromus pubescens*, *Paronychia virginica*, *Ageratina altissima*, *Silphium radula*, *Mitreola petiolata*, *Aquilegia canadensis*, *Hypericum drummondii*, and *H. mutilum*. A brief summary of the early botanical exploration of the Plateau region is in Singhurst et al. (2007).

KWMA was purchased from the Presbyterian MO Ranch Assembly by the Texas Game and Fish Com-

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mission (now Texas Parks and Wildlife Department) in June 1950 with funds made available by the Pittman-Robertson Wildlife Restoration Act. The initial purpose of KWMA was to serve as a wildlife research and demonstration area where biologists could study and evaluate wildlife and habitat management practices. During the 1960s, the objectives of the KWMA were expanded to include maintaining optimal productivity of range land, thus maximizing monetary return, while sustaining maximum wildlife resources. This objective permitted the initial habitat manipulation, particularly the clearing of large areas of mature Ashe juniper (*Juniperus ashei*) for both range and wildlife habitat enhancement. In 1989, more flexible multiple-use goals, which included research, demonstration, education, preservation, conservation, and recreation, were adopted and are currently used as a management guide.

MATERIALS AND METHODS

The checklist is largely based upon examination of specimens collected between 1955 and 2001 which are deposited in the Baylor University Herbarium (BAYLU). Additional specimens from the University of Texas Herbarium (TEX and LL), Kerr WMA Herbarium (acronym KWMA used within), and the S.M. Tracy Herbarium (TAES) were also examined. Field studies were conducted from 2006 through spring 2009, with emphasis on finding species expected to be present, but not yet vouchered. These specimens were also deposited at BAYLU.

Nomenclature generally follows that of Correll and Johnston (1970), with updates and corrections as needed from Hatch et al. (1990), Jones et al. (1997), and NRCS, USDA (2010).

The vegetational analysis compared species richness of floristic inventories of various areas (see Table 1) of Texas. Documented species lists were compared against Arrhenius' (1921) model subsequently adapted by Williams and Lutterschmidt (2006) in order to determine the adequacy of the KWMA sampling effort. Species richness and geographic area of KWMA, nine selected sites, and the state of Texas, were log-transformed into a database. A statistical relation of species richness as a function of geographic area produces a theoretical slope (*z*) and intercept (*d*) based on this formula: $S = dA^z$ (Arrhenius 1921). A linear function is created from this log-transformed data and the slope determines a theoretical value of species fidelity equated per unit area and thereby an empirical measure of sampling effort. Arrhenius (1921) first fit a model to data on increasing species number with increasing size of area sampled. Relationship between species and area partly arises because of increasing likelihood of habitat diversity with increasing area sampled (Diamond 1988). Arrhenius explicitly stated that his power formula, $S = S(A) = dA^z$, was empirical and should be regarded as an approximation whose existence was entirely dependent on agreement with data from lists of flora that he had obtained. Because his formula calculated an average number of species occurring in an area, he also contemplated the problem of establishing a stochastic model for species richness in smaller land parcels consumed by a larger land mass. In order to relate area to species occurrence, Arrhenius assumed that any individual of any species of this smaller area must have an equal opportunity of occurrence in the larger area and thus probability could be expected. However, expectation in occurrence contrasts sharply with the difficulties of explaining variance by this equation (Ugland et al. 2003). It is suggested that a disturbance regime, or lack of one, is a significant contributor to relationship exceptions and variance. Similar approaches have been taken more or less independently by several authors who examined the distribution of individuals and presence/absence pattern of species (e.g. Gleason 1922; Hurlbert 1971; Heck et al. 1975; Brewer & Williamson 1980; Coleman 1981; Ney-Nifle & Mangel 1999; Williams & Lutterschmidt 2006). All of the proposed formulae may be regarded as variants of Arrhenius's (1921) original model. For an historical review of species-area curves, see McGuinness (1984).

The Sørenson coefficient (1948; also known as "quotient of similarity," was used as a community similarity index to compare KWMA to both Mason Mountain WMA and Enchanted Rock State Natural Area (ERSNA) to quantitatively assess the best floristic comparison. Numbers of species within each of the three areas were cross-checked for commonality of species occurrence and used as: $CC_s = 2c / s_1 + s_2$, where s_1 and s_2 are species number in communities 1 and 2, respectively, c is the number of species common to

TABLE 1. Known values of species richness for vascular plants and associated geographic area from published and unpublished inventories in Texas, USA.

Region	Species number	Predicted Species	Area (km2)	Citation
Amistad NRA	707	498.96	57.4242	Poole (unpub.)
Big Lake Bottom WMA	459	413.09	17.0182	Fleming et al. 2002
Enchanted Rock SNA	555	357.61	6.7234	O'Kennon (unpub.)
Fairfield Lake SRA	497	351.06	5.9697	Do 1996
Fort Hood Military Res.	988	764.55	896.3829	Hansen (unpub.)
Gus Engeling WMA	920	480.60	45.1060	Singhurst et al. 2003
Kerr WMA	719	442.84	26.6313	Singhurst et al. this paper
Madison County	985	803.69	1236.3422	Neill and Wilson 2001
Mason Mountain WMA	693	428.93	21.6859	Singhurst et al. 2007
McLennan County	1118	907.22	2697.5428	Hannick 2009 (unpub. thesis)
Texas	5524	2140.26	677940.3	Diggs et al. 1999

both communities. The value of CC_S ranges from 0 (when no species are common to either community) to 1.0 (when all species are found in each community of interest).

The Sørenson coefficient is an adaptation of Jaccard's (1902) coefficient of community originally stated as: $CC_J = c / (s_1 + s_2) - c$ and was originally utilized to accompany data consisting of presence or absence of species. The following caution should be noted: for a given amount of similarity between communities, the similarity indices (Sørenson and Jaccard) do not necessarily express the same quantitative values. Thus, both express similarity between communities, but should not be compared against each other. Assessment of overlapping plant associations and groupings applying similarity indices are attempts to quantify niche overlap, an arena of significant disagreement among contemporary ecologists (Looman & Campbell 1960; Hurlbert 1978; Abrams 1980; Wallace 1981; Hurlbert 1982; Abrams 1982; Ungland et al. 2003).

Based on dominant species, landscape position, and soil water content, natural plant community associations (NatureServe 2008) and land use classes were circumscribed and mapped for KWMA utilizing 1996 digital orthophoto aerial photography and ERDAS Imagine 8.7 software (Leica Geosystems 2008).

DESCRIPTION OF STUDY AREA

KWMA consists of 2635.5 ha (6514.9 acres) located 35.5 km (22 miles) west of Kerrville, Texas. The topography, soil types, and vegetation of KWMA are representative of the surrounding Edwards Plateau Ecological Region. Soils are generally rocky and shallow, covering a substratum of limestone. Topography is gently rolling to hilly with occasional draws (a shallow, open, natural, drainage) and small canyons. Annual rainfall from 1951 to 1986 averaged 64.7 cm (25.48 inches), with the wettest months being April, May, June, August, September, and October. KWMA is drained by the North Fork of the Guadalupe River which also forms part of the southern boundary. Most drainages are intermittent. Several small springs and the Guadalupe River provide the only natural permanent water sources. Elevation varies from 588.3 m (1930 feet) to 682.8 m (2240 feet), with average elevation being 609.6 m (ca. 2000 feet). With respect to management at KWMA, practices used are designed to encourage perennial bunch grasses and maintain a high diversity of herbaceous annuals and perennials and include prescribed burning (especially winter burns), cedar control on dry uplands, and light grazing.

KWMA supports a diversity of native wildlife species. These include white-tailed deer (*Odocoileus virginianus*), Rio Grande wild turkey (*Meleagris gallopavo intermedia*), javelina (*Pecari tajacu*), eastern cottontail rabbit (*Sylvilagus floridanus*), black-tailed jackrabbit (*Lepus californicus*), northern raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and Virginia opossum (*Didelphis virginiana*), all being abundant. Larger predators such as coyote (*Canis latrans*) and bobcat (*Lynx rufus*) are uncommon. Historically, mountain lion (*Felis concolor*), American black bear (*Ursus americanus*), and gray wolf (*Canis lupus*) inhabited the area, but all have been extirpated. Hahn (1951) reported that black bear was present in this vicinity as late as 1905 and the last recorded killing of a gray wolf was at the head of the North Fork of the Guadalupe River in 1913. KWMA has recorded 191 species of resident and migratory birds and 29 species of herpetofauna. Exotic wildlife species intentionally introduced to the area are axis deer (*Axis axis*), aoudad sheep (*Ammotragus lervia*), and sika deer (*Cervus nippon*). Also present is the feral hog (*Sus scrofa*), which probably originated from escaped stock.

Three federally listed endangered species occur on KWMA. These include two birds, the black-capped vireo (*Vireo atricapillus*) and the golden-cheeked warbler (*Dendroica chrysoparia*) and one plant, the Tobusch fishhook cactus (*Sclerocactus brevihamatus* ssp. *tobuschii*).

RESULTS AND DISCUSSION

Twenty-one natural plant community associations (NatureServe 2008) and three land use classes were determined to be present in KWMA. Two natural associations, Sawgrass-Spikesedge-Beakrush-Black Bogrush-Aparejograss Herbaceous Vegetation Association and Ashe Juniper - Bastard Oak - Plateau Live Oak Woodland are described as new associations for Texas. The other associations are of common occurrence in the Edwards Plateau vegetational area. Land use classes include developed, old field and reservoirs. For the purpose of organization, the plant community association descriptions are separated into system categories that include uplands, canyons, cliff faces, floodplain, springs, seeps, and aquatic types, and land use classes. In general, the associations are discussed from north to south. All references to geology are based upon the Llano [Map] Sheet, University of Texas Bureau of Economic Geology, 1981.

NATURAL TERRESTRIAL ASSOCIATIONS

Upland Types

Plateau Live Oak / Curly-mesquite Woodland Vegetation Association (Allard 1990, Diamond 1993) occurs on limestone with clay soils in the Edwards Plateau. Normally it is found on flat to moderately rolling terrain of 0–5% slope. It comprises 60.7 ha (150.1 ac) and is developed on the lower Cretaceous Segovia Member of the Edwards Limestone Formation. This association is concentrated in the northwestern portion of KWMA (Fig. 1). The vegetation is dominated by *Quercus fusiformis* and grasslands or grassy openings with *Bouteloua curtipendula* (both varieties), *Hilaria belangeri*, and *Schizachyrium scoparium*. Other important components in the understory include *Condalia hookeri*, *C. spathulata*, *Juniperus ashei*, *Quercus buckleyi*, *Q. sinuata* var. *breviloba*, *Q. stellata* var. *stellata*, *Rhus lanceolata*, *R. trilobata*, and *Ulmus crassifolia*.

Post Oak - Blackjack Oak / Little Bluestem Woodland Vegetation Association (Diamond 1993; Hoagland 2000) occurs over shallow soils on limestone mesa tops in the Cross Timbers and Prairies, Edwards Plateau, and Post Oak Savanna Ecoregions in Texas as well as Cross Timbers in Kansas and Oklahoma. Land form is flat to rolling with 0–5% slope. Approximately 70.7 ha (174.7 ac) of KWMA consists of this formation, which is developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. This association is found in the northern portion of KWMA (Fig. 1). The area is dominated by *Quercus stellata* var. *stellata*, *Q. marilandica*, and *Schizachyrium scoparium* and varies from open woodland to savanna. Shrub species include *Diospyros texana*, *Cylindropuntia leptocaulis*, and *Smilax bona-nox*. Dominant grasses and forbs include *Andropogon gerardii*, *Berlandiera betonicifolia*, *Carex planostachys*, *Cheilanthes tomentosa*, *Cocculus carolinus*, *Cyperus rotundus*, *Heterotheca subaxillaris*, *Hypericum drummondii*, *Leptochloa dubia*, *Matelea gonocarpos*, and *Sorghastrum nutans*. Generally, there is low forb diversity.

Plateau Live Oak - Post Oak Savanna Vegetation Association (Diamond 1993; Hoagland 2000) occurs over shallow soils on limestone mesa tops in the Edwards Plateau and Post Oak Savanna Ecoergions in Texas and in the Quartz and Wichita Mountains in Oklahoma. The association is found on flat to rolling terrain with 0–5% slope on the lower Cretaceous Segovia Member of Edwards Limestone Formation. Approximately 120.3 ha (297.3 ac) of the association occur in the northern and eastern portion of KWMA (Fig. 1). Dominant plants are *Quercus fusiformis*, *Q. stellata* var. *stellata*, *Diospyros texana*, and *Schizachyrium*

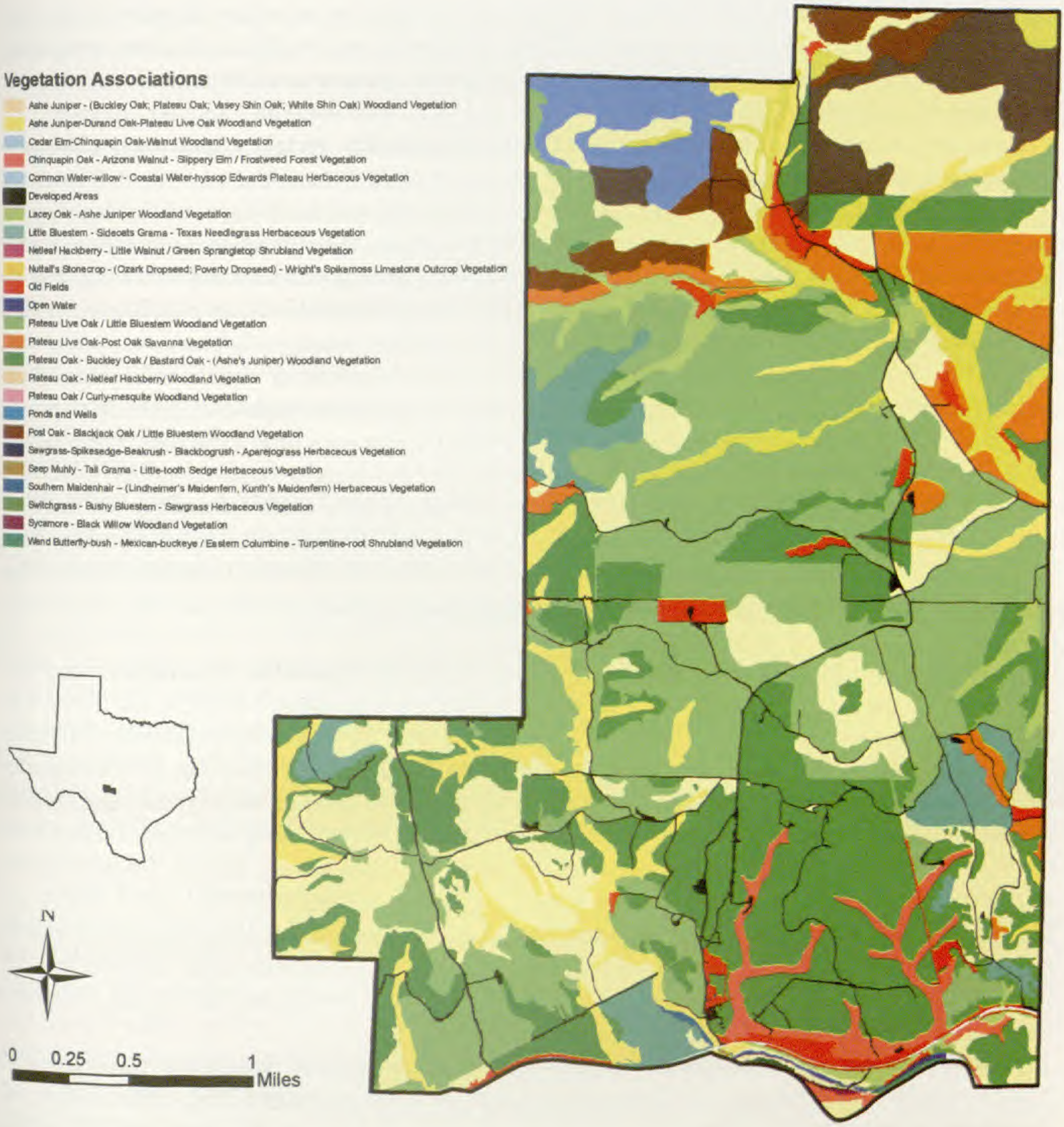
Vegetation Associations
Ashe Juniper - (Buckley Oak; Plateau Oak; Vasey Shin Oak; White Shin Oak) Woodland Vegetation
Ashe Juniper-Durand Oak-Plateau Live Oak Woodland Vegetation
Cedar Elm-Chinquapin Oak-Walnut Woodland Vegetation
Chinquapin Oak - Arizona Walnut - Slippery Elm / Frostweed Forest Vegetation
Common Water-willow - Coastal Water-hyssop Edwards Plateau Herbaceous Vegetation
Developed Areas
Lacey Oak - Ashe Juniper Woodland Vegetation
Little Bluestem - Sideoats Grama - Texas Needlegrass Herbaceous Vegetation
Netleaf Hackberry - Little Walnut / Green Sprangletop Shrubland Vegetation
Nuttall's Stonecrop - (Ozark Dropseed; Poverty Dropseed) - Wright's Spikemoss Limestone Outcrop Vegetation
Old Fields
Open Water
Plateau Live Oak / Little Bluestem Woodland Vegetation
Plateau Live Oak-Post Oak Savanna Vegetation
Plateau Oak - Buckley Oak / Bastard Oak - (Ashe's Juniper) Woodland Vegetation
Plateau Oak - Netleaf Hackberry Woodland Vegetation
Plateau Oak / Curly-mesquite Woodland Vegetation
Ponds and Wells
Post Oak - Blackjack Oak / Little Bluestem Woodland Vegetation
Sawgrass-Spikesedge-Beakrush - Blackbogrush - Aparejograss Herbaceous Vegetation
Seep Muhly - Tall Grama - Little-tooth Sedge Herbaceous Vegetation
Southern Maidenhair – (Lindheimer's Maidenfern, Kunth's Maidenfern) Herbaceous Vegetation
Switchgrass - Bushy Bluestem - Sawgrass Herbaceous Vegetation
Sycamore - Black Willow Woodland Vegetation
Wand Butterfly-bush - Mexican-buckeye / Eastern Columbine - Turpentine-root Shrubland Vegetation
N
0
0.25
0.5
1
Miles

Fig. 1. The inset map shows Kerr County and vicinity map showing Kerr Wildlife Management Area Vegetation Associations (Leica Geosystems 2008, NatureServe 2008)

scoparium. Shrub species include *Mahonia trifoliolata* and *Opuntia engelmannii* var. *lindheimeri*. Dominant grasses include *Bothriochloa laguroides*, *Bouteloua curtipendula* (both varieties), *B. pectinata*, *B. rigidiseta*, *Hilaria belangeri*, *Muhlenbergia reverchonii*, and *Panicum virgatum*. A moderate diversity of forbs is present.

Plateau Live Oak / Little Bluestem Woodland Vegetation Association (Diamond 1993) occurs on gently sloping to nearly flat slopes in the eastern Edwards Plateau and Cross Timber Ecoregons in Texas and in Quartz and Wichita Mountains in Oklahoma. This association consists of about 739.5 ha (1827.4 ac) found on flat to rolling upland landscape with 0–5% slope. It is best developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. The association is concentrated in the central and southwestern portion of KWMA (Fig. 1). The area is dominated by *Quercus fusiformis* and *Schizachyrium* *scoparium*. Important shrubs and small trees include *Celtis laevigata* var. *reticulata*, *Diospyros texana*, and *Mahonia trifoliolata*. Dominant grasses include *Aristida purpurea* (several varieties), *Bouteloua curtipendula* (both varieties), *B. pectinata*, *B. rigidiseta*, and *Nassella leucotricha*. An extensive diversity of forbs can occur in this association.

Nuttall's Stonecrop - (Ozark Dropseed, Poverty Dropseed) - Wright's Spikemoss Limestone Outcrop Vegetation Association (NatureServe 2008) consists of 246.9 ha (610.2 ac) of exposed limestone surfaces in the Edwards Plateau. It is typical of flat upland landscape with 0–1% slope and developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. The association is concentrated in the southwest and southeast portion of KWMA (Fig. 1). This association is characterized by shallow pothole depressions that accumulate soils or serve as ephemeral pools. It is dominated by *Sedum nuttallianum*, *Sporobolus ozarkanus*, *S. vaginiflorus*, and *Selaginella wrightii*. *Nostoc commune* Vaucher (Cyanophyta, Nostocaceae) is common during wet periods. Bare rock is occupied by scattered patches of crutose and foliose lichens and bryophytes (Musci). Typical ferns are *Cheilanthes tomentosa* and *Pellaea wrightiana*. Other characteristic vegetation includes annuals (ephemerals) and species adapted to bare rock xeric conditions. These include *Allium drummondii*, *Ammannia coccinea*, *Arenaria benthamii*, *Aristida oligantha*, *Bouteloua hirsuta*, *Centaurium calycosum*, *Chaetopappa asteroides*, *Cooperia pedunculata*, *Crassula aquatica*, *Croton monanthogynus*, *Draba cuneifolia*, *Echinochloa walteri*, *Erioneuron pilosum*, *Hedeoma drummondii*, *Hedyotis crassifolia*, *Heteranthera dubia*, *Juncus marginatus*, *Ludwigia repens*, *Nothoscordum bivalve*, *Paronychia lindheimeriana*, *P. virginica*, *Phemeranthus aurantiacus*, *Plantago virginica*, *Polygala lindheimeri*, *Scutellaria drummondii*, *Verbena canescens*, and *Veronica peregrina*.

Ashe Juniper - Bastard Oak - Plateau Live Oak Woodland Vegetation Association occurs over shallow soils on limestone mesa tops in the Edwards Plateau. This association is found on flat terrain with 0–2% slope and consists of 173.8 ha (429.6 ac) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. It is found along drainages throughout the management area (Fig. 1). The vegetation is dominated by *Juniperus ashei* and *Quercus sinuata* var. *breviloba*, with densities varying from open to closed canopy woodlands. When canopy cover is dense, *Quercus sinuata* var. *breviloba* is sometimes limited to the understory. Other components in the understory include *Cercis canadensis* var. *texensis*, *Diospyros texana*, *Forestiera pubescens*, *Fraxinus texensis*, *Ilex decidua*, *Lonicera albiflora*, *Mahonia trifoliolata*, *Quercus buckleyi*, *Q. fusiformis*, *Rhus trilobata*, *R. virens*, *Sophora secundiflora*, *Toxicodendron radicans*, *Ulmus crassifolia*, *Ungnadia speciosa*, and *Yucca rupicola*. Herbaceous cover is generally sparse, especially with dense canopies, and may include *Carex planostachys*, *Commelina erecta*, *Galactia texana*, *Matelea edwardsensis*, *M. reticulata*, *Lespedeza texana*, *Rhynchosia senna*, *Sporobolus compositus*, and *Tragia ramosa*.

Little Bluestem - Sideoats Grama - Texas winter-grass herbaceous Vegetation Association is a midgrass grassland and characteristic of uplands over relatively deep soils in the Rolling Plains of Texas, but also in the central and western Edwards Plateau (Diamond 1993). This association is found on flat to rolling terrain with 0–5% slope. It includes 306.8 ha (758.1 ac) on the lower Cretaceous Fort Terrett and Segovia Member of Edwards Limestone Formation in the western and southern portion of KWMA (Fig. 1). The area is dominated by *Schizachyrium scoparium*, *Bouteloua curtipendula* (both varieties), and *Nassella leucotricha*. Trees speceis include *Juniperus ashei* and *Prosopis glandulosa*. Shrub species include *Opuntia engelmannii* var. *lindheimeri*, and *Ziziphus obtusifolia*. Typical grasses include *Aristida purpurea* (several varieties), *Bothriochloa barbinodis*, *Bouteloua barbata*, *Digitaria californica*, *Hilaria belangeri*, *Panicum obtusum*, *Sorghastrum nutans*, and *Tridens muticus*. An extensive diversity of forbs can occur in this association.

Ashe Juniper - (Buckley Oak, Plateau Live Oak, Vasey Shin Oak, Bastard Oak) Woodland Vegetation Association (Diamond 1993) consists of woodlands over shallow soils on limestone slopes in the Edwards Plateau. This association is found on flat to rolling terrain with 0–5% slope and consists of 413.3 ha (1021.2 ac) on the lower Cretaceous Fort Terrett and Segovia Member of Edwards Limestone Formation. The association is scattered throughout the KWMA (Fig. 1). Dominants are *Juniperus ashei* with mixtures of *Quercus buckleyi*, *Q. fusiformis*, *Q. pungens* var. *vaseyana*, and *Q. sinuata* var. *breviloba*. Tree species include *Celtis laevigata* var. *reticulata* and *Fraxinus texensis*. Shrub species include *Diospyros texana*, *Mahonia trifoliolata*, *Nolina texana*, *Rhus virens*, *Toxicodendron radicans*, and *Yucca rupicola*. Herbaceous flora include *Bouteloua curtipendula* (both varieties), *Carex planostachys*, *Lespedeza texana*, and *Schizachyrium scoparium*.

Plateau Live Oak - Buckley Oak / Bastard Oak - (Ashe Juniper) Woodland Vegetation Association (NatureServe 2008) consists of woodlands occurring over shallow soils on limestone mesa tops in the Edwards Plateau. This association is found on flat to rolling terrain with 0–5% slope and consists of 713.1 ha (1762 ac) on the lower Cretaceous Fort Terrett and Segovia Member of Edwards Limestone Formation. The association is scattered throughout the management area (Fig. 1). It is dominated by *Quercus fusiformis*, *Q. buckleyi*, and *Juniperus ashei* and characterized by a mixture of other trees and shrubs such as *Celtis laevigata* var. *reticulata*, *Cercis canadensis* var. *texensis*, *Forestiera pubescens*, *Frangula caroliniana*, *Fraxinus texensis*, *Ilex decidua*, *Lonicera albiflora*, *Opuntia engelmannii* var. *lindheimeri*, *Quercus sinuata* var. *breviloba*, *Sideroxylon lanuginosum*, *Rhus trilobata*, *Toxicodendron radicans*, *Ulmus crassifolia*, and *Ungnadia speciosa*. Herbaceous species include *Carex planostachys*, *Chaerophyllum tainturieri*, *Limnodea arkansana*, and *Nassella leucotricha*.

Canyon Types

Chinquapin Oak - Arizona Walnut - Slippery Elm / Frostweed Forest Vegetation Association (Diamond 1993) occurs on mesic limestone slopes in the Edwards Plateau. This association is found on moderate to steep slopes (5–20% slope) at KWMA. It consists of 49.5 ha (122.3 ac) and is developed on the lower Cretaceous Fort Terrett Member of Edwards Limestone Formation. This association is found in the southeastern portion of KWMA (Fig. 1). The vegetation is dominated by *Quercus muehlenbergii*, *Juglans major*, *Ulmus rubra*, and *Verbesina virginica*. Other tree species include *Carya illinoinensis*, *Fraxinus texensis*, *Quercus buckleyi*, *Morus rubra*, and *Ulmus crassifolia*. Subcanopy species include *Morus microphylla* and *Juniperus ashei*. A diversity of shrubs and woody vines may include *Aesculus pavia* var. *pavia*, *Cornus drummondii*, *Garrya ovata* ssp. *lindheimeri*, *Frangula caroliniana*, *Ilex decidua*, *Parthenocissus quinquefolia*, and *Viburnum rufidulum*. Herbaceous species include *Adiantum capillus-veneris*, *Carex edwardsiana*, *C. planostachys*, *Galium texense*, *Brickellia cylindracea*, *Chaetopappa effusa*, *Desmodium paniculatum*, *Geum canadense*, *Packera obovata*, and *Tripsacum dactyloides*.

Cedar Elm - Chinquapin Oak - Arizona Walnut Woodland Vegetation Association occurs on mesic limestone slopes in the Edwards Plateau. This association is found on moderately steep slopes (5–15%) at KWMA and includes 1.1 ha (2.7 ac) on the lower Cretaceous Fort Terrett Member of Edwards Limestone Formation. This association is found in the southeastern portion of KWMA (Fig. 1). The vegetation dominated by *Ulmus crassifolia*, *Quercus muehlenbergii*, and *Juglans major*. The understory consists of *Bromus pubescens*, *Carex planostachys*, *Chasmanthium latifolium*, *Elymus virginicus*, *Panicum virgatum*, and *Verbesina virginica*.

Lacey Oak - Ashe Juniper Woodland Vegetation Association (Diamond 1993) occurs on rocky canyon slopes or on shallow soils that have developed over limestone in the southern and southwestern portion of the Edwards Plateau. This association is found on moderately to steep slopes (5–35%) at KWMA and includes 52.8 ha (130.4 ac) on the lower Cretaceous Fort Terrett and Segovia Member of Edwards Limestone Formation. The association is concentrated in the eastern and western portion of KWMA (Fig. 1). The area is dominated by *Quercus laceyi* and *Juniperus ashei*. Other important canopy components include *Quercus buckleyi*, *Q. fusiformis*, *Q. muehlenbergii*, and *Ulmus crassifolia*. Understory shrubs include *Cornus drummondii*, *Ilex decidua*, *Ptelea trifoliata*, and *Ungnadia speciosa* (Riskind and Diamond 1988).

Cliff Face Types

Wand Butterfly-bush - Mexican buckeye / American Columbine - Dutchman's pipe Shrubland Vegetation Association (NatureServe 2008) occurs on limestone rim rock along mesic canyons in the southern portion of the Edwards Plateau. This association is found on very steep slopes to vertical cliff faces and comprises 4.2 ha (10.3 ac) on the lower Cretaceous Fort Terrett Member of Edwards Limestone Formation. It is limited to the southeastern portion of area (Fig. 1). Typical dominants are *Buddleja racemosa* ssp. *incana*, *Ungnadia speciosa*, *Aquilegia canadensis*, and *Aristolochia serpentaria*. Other shrubs include *Ageratina havanensis*, *Croton*

fruticulosus, *Eysenhardtia texana*, *Morus microphylla*, *Nolina lindheimeri*, *N. texana*, *Parthenocissus quinquefolia*, *Petrophytum caespitosum*, *Rhus trilobata*, *R. virens*, *Toxicodendron radicans*, and *Yucca rupicola*. Characteristic herbaceous species included *Acalypha phleoides*, *Aristolochia coryi*, *Asplenium resiliens*, *Brickellia cylindracea*, *Chamaesyce villifera*, *Cheilanthes alabamensis*, *C. horridula*, *Desmodium psilophyllum*, *Lespedeza texana*, *Linum rupestre*, *Pellaea atropurpurea*, *P. ovata*, *Perityle lindheimeri*, *Polygala lindheimeri*, *Phyllanthus polygonoides*, and *Salvia roemeriana*.

NATURAL AQUATIC ASSOCIATIONS

Floodplain Types

Plateau Live Oak - Netleaf Hackberry Woodland Vegetation Association (Diamond 1993) occurs along dry to mesic flood plains of streams on the Edwards Plateau, South Texas Plains, and Trans Pecos Ecoregions. This association consists of 81.5 ha (201.5 ac) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. It is limited to northwestern portion of KWMA (Fig. 1). The association is dominated by *Quercus fusiformis* and *Celtis laevigata* var. *reticulata*. Other trees and shrubs include *Juglans major*, *Diospyros texana*, *Fraxinus texensis*, *Juniperus ashei*, and *Ulmus crassifolia*. Forb diversity is generally low.

Netleaf Hackberry - Little Walnut / Green Sprangletop Shrubland Vegetation Association (Diamond 1993) occurs along dry to intermittent streams on the Edwards Plateau and Chihuahuan Desert. This association comprises 81.2 ha (200.7 ac) in the northwestern part of KWMA (Fig. 1) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. Vegetation is dominated by *Celtis laevigata* var. *reticulata* and *Juglans microcarpa*. Other woody plants include *Diospyros texana*, *Fraxinus texensis*, *Sideroxylon lanuginosum* ssp. *albicans*, and *Smilax bona-nox*. Characteristic herbs can include *Bothriochloa barbinodis* var. *barbinodis*, *Bouteloua curtipendula* (both varieties), and *Leptochloa dubia*.

Sycamore - Black Willow Woodland Vegetation Association (NatureServe 2008) occurs along periodically scoured flat-bedded limestone on relatively flat terrain along creekbeds and riverbeds in the Edwards Plateau and adjacent areas. It consists of small narrow strips typically not more than 10 m wide in moist to wet gravelly soils. This association consists of 2.5 ha (1.0 ac) along the shores of the North Fork of the Guadalupe River developed on the lower Cretaceous Fort Terrett Member of Edwards Limestone Formation and is limited to the southeastern portion of KWMA (Fig. 1). This association is dominated by *Platanus occidentalis* and *Salix nigra*, often as scattered small trees since this association receives frequent catastrophic floods. Another tree species that infrequently occupies this community is *Populus deltoides*. A poorly developed shrub layer included *Amorpha fruticosa*, *Baccharis neglecta*, *Cephalanthus occidentalis*, and *Juglans microcarpa*. Herbaceous species varies with moisture, disturbance, and other factors.

Spring, Seep, and Aquatic Types

Switchgrass - Bushy Bluestem - Jamaica Sawgrass Herbaceous Vegetation Association (NatureServe 2008) occurs along periodically scoured flat-bedded limestone shores of perennial streams on the Edwards and Stockton Plateaus. Terrain is relatively flat. The association is comprised of herbaceous flora that is rooted in cracks and in soil mats along the edges and minor shelves along the river's edge of the North Fork of the Guadalupe River. This association consists of 1.3 ha (3.2 ac) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation and is limited to the southeastern portion of KWMA (Fig. 1). The dominants include *Panicum virgatum*, *Andropogon glomeratus*, and *Cladium mariscus* ssp. *jamaicense*. This stream-scoured grassland varies in density from very open to dense. Woody shrubs and trees may occur as scattered individuals, and may include *Platanus occidentalis*, *Salix nigra*, *Juglans microcarpa*, *Baccharis neglecta*, and *B. salicifolia*. Herbaceous flora includes *Eleocharis caribaea*, *E. montevidensis*, *Eupatorium serotinum*, *Fuirena simplex*, *Indigofera lindheimeriana*, *Ratibida columnifera*, *Rhynchospora corollata*, *R. nivea*, *Schizachyrium scoparium*, and *Solidago altissima*.

Sawgrass - Spikesedge - Beakrush/Whitetop - Black bogrush - Aparejograss Herbaceous Vegetation Association occurs along spring and seep influenced herbaceous wetlands along creeks and rivers of the Edward Plateau. Sites are dominated by sedges, grasses, and other herbaceous flora. This association includes 4.1 ha (10.0 ac) along the shores of the North Fork of the Guadalupe River in the southwestern portion of KWMA (Fig. 1) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. Dominants include *Cladium mariscus* ssp. *jamaicense*, *Eleocharis rostellata*, *E. montevidensis*, *E. caribea*, *Rhynchospora capillacea*, *R. nivea*, and *R. colorata*, *Schoenus nigricans*, and *Muhlenbergia utilis*. The substrate includes well developed marl clays and gravels over limestone bed rock. Sites occur as braided mats of vegetation in mucky soils originating at spring sources (spring heads on slopes or bases of limestone bluffs). The sites can extend into the floodplain of the river as a matrix of patchy islands of well developed muck with small streamlet channels braiding through the vegetation patches. Seepage slopes are spongy. High concentrations of calcium carbonate cake layers can be present. Significant herbaceous plants often associated with this wetland community include *Adiantum capillus-veneris*, *Andropogon glomeratus*, *Carex edwardsiana*, C. microdonta, *C. muhlenbergii*, *Bidens laevis*, *Boehmeria cylindrica*, *Centella asiatica*, *Epipactus gigantea*, *Fimbristylis puberula*, *Fuirena simplex*, *Helenium microcephalum* var. *microcephalum*, *Juncus texanus*, *Ludwigia repens*, *Lythrum ovalifolium*, *Mitreola petiolata*, *Nasturtium officinale*, *Lobelia cardinalis*, *Muhlenbergia lindheimeri*, *M. reverchonii*, *Dichanthelium acuminatum* var. *lindheimeri*, *D. oligosanthes* var. *scribnerianum*, *Panicum virgatum*, *Pluchea odorata*, *Sorghastrum nutans*, *Symphyotrichum praealtum*, *Paspalum pubiflorum*, *Thelypteris ovata* var. *lindheimeri*, *Utricularia gibba*, *Verbena scabra*, and *Verbesina lindheimeri*. The few woody species that occur in these wetlands include *Cephalanthus occidentalis*, *Lindera benzoin*, *Platanus occidentalis*, and *Salix nigra*. Unusual species include *Rhynchospora capillacea*, *Rudbeckia fulgida*, and *Scleria verticillata*.

Seep Muhly - Tall Grama - Little-tooth Sedge Herbaceous Vegetation Association (NatureServe 2008) occurs on ephemeral moist, open, rocky slopes on the Edwards Plateau. This association includes 0.2 ha (0.4 ac) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation and is limited to the southeastern portion of KWMA (Fig. 1). The dominants include *Muhlenbergia reverchonii*, *Bouteloua pectinata*, and *Carex perdentata*. Other herbaceous species *Agalinis edwardsiana*, *Aristida purpurea* (several varieties), *Calylophus berlandieri*, *Carex planostachys*, *Centaurium beyrichii*, *Desmanthus velutinus*, *Galphimia angustifolia*, *Hedeoma drummondii*, *Heliotropium tenellum*, *Liatris mucronata*, *Marshallia caespitosa*, *Melampodium leucanthum*, *Oenothera triloba*, *Paronychia virginica*, *Pediomelum hypogaeum*, *Polygala alba*, *P. lindheimeri*, *Salvia texana*, *Spiranthes magnicamporum*, *Stenaria nigricans* var. *nigricans*, *Stillingia texana*, *Tetraneuris scaposa*, *Thamnosma texana*, *Thelesperma simplicifolium*, *Vernonia lindheimeri*, and *Wedelia texana*.

Southern Maidenhair - (Lindheimer's Maidenfern, Kunth's Maidenfern) Herbaceous Vegetation Association (NatureServe 2008) occurs on cliff faces and lower slopes of forested box canyons on the Edwards Plateau, usually in narrow horizontal bands where seepage from exposed limestone or water from perennial or nearly perennial creeks consistently provides greater moisture than is available on adjacent slopes. This association consists of 4.2 ha (10.3 ac) developed on the lower Cretaceous Fort Terrett Member of Edwards Limestone Formation in the southeastern portion of KWMA (Fig. 1). The area is dominated by *Adiantum capillus-veneris* and *Thelypteris ovata* var. *lindheimeri*. Other prominent herbaceous species are *Epipactus gigantea*, *Hydrocotyle verticillata*, *Dichanthelium acuminatum* var. *lindheimeri*, *Samolus valerandi* ssp. *parviflorus*, and *Silphium radula*.

American Water-willow - Coastal Water-hyssop Edwards Plateau Herbaceous Vegetation Association (NatureServe 2008) occurs on relatively permanently watered streams which flow over flat-bedded limestone strata on the Edwards Plateau. This association consists of 0.3 ha (0.6 ac) developed on the lower Cretaceous Segovia Member of Edwards Limestone Formation. It is present in the southern portion of KWMA (Fig. 1). The dominants include *Justicia americana* and *Bacopa monnieri*. Other herbaceous flora includes *Cyperus* spp., *Fuirena simplex*, *Eleocharis caribaea*, *E. montevidensis*, *Lobelia cardinalis*, *Ludwigia palustris*, *Rhynchospora colorata*, and *R. nivea*.

LAND USE ASSOCIATIONS

Developed land (Fig. 1) consists of about 61.5 ha (152 ac) that are heavily impacted by human use, such as lawns and parking areas near buildings, roads, etc. Typically, these areas are occupied by early successional flora hat vary from season to season and frequency of disturbance. Herbaceous flora include *Capsella bursa-*

pastoris, *Erodium cicutarium*, *Geranium texanum*, *Glandularia bipinnatifida* var. *bipinnatifida*, *Krigia caespitosa*, *Lamium amplexicaule*, *Lepidium virginicum*, *Plantago virginica*, *Stellaria media*, and *Veronica peregrina*.

Old field vegetation (Fig. 1) consists of 64.7 ha (159.9 ac) of mostly non-native grasses and dominated by *Bothriochloa ischaemum*. Herbaceous vegetation is quite variable and includes plants such as *Asclepias viridiflora*, *Bromus unioloides*, *Conyza canadensis*, *Cucurbita foetidissima*, *Glandularia bipinnatifida* var. *bipinnatifida*, *Gutierrezia texana*, *Hordeum pusillum*, *Lygodesmia texana*, *Melilotis officinalis*, *Ratibita columnifera*, *Ruellia nudiflora*, *Salvia farinacea*, *Sida abutifolia*, *Solanum* spp., *Verbascum thapsus*, *Verbena officinale*, and *Vulpia octoflora*.

Ponds and wells (Fig. 1) consists of 0.1 ha (0.3 ac) of mostly marginal and shallow ponds and wells dominated by emergent rushes, sedges, and grasses. Herbaceous vegetation includes Agalinis homolantha, *Ammannia coccinea*, *Cyperus erythrorhizos*, *C. strigosus*, *Echinochloa walteri*, *Eleocharis montevidensis*, *Juncus interior*, and *J. marginatus*. Other associated flora includes *Eclipta prostrata*, *Helenium elegans*, *Lindernia dubia*, *Marsilea vestita*, *Mecardonia procumbens*, *Pluchea odorata*, and *Xanthium strumarium*.

VEGETATIONAL ANALYSIS

Figure 2 demonstrates an adequate sampling indicated by the Kerr WMA datum point above the slope of the determined function, moreover data for both MMWMA and ERSNA place those sampling efforts above this slope-line suggesting these proximal locales can be compared legitimately. The Sørenson coefficient designates MMWMA as more analogous in floristic composition than ERSNA and the statistic for Jaccard's coefficient of community is in agreement with that floristic similarity (Table 2).

Summary Data of the Flora

The vascular flora of KWMA consists of 719 taxa (species and below). Families represented by the largest number of species are Asteraceae (with 113 species), Poaceae (109), Fabaceae (38) and Euphorbiaceae (34). Apparently, the drier nature of KWMA is more agreeable to the Euphorbiaceae and less so for the Cyperaceae, which is the fourth largest family within Texas. The Cyperaceae is represented by 27 species in KWMA, which includes four species of *Carex* and nine species of *Cyperus*, while in Texas as a whole these two genera have 96 and 56 species respectively. Other large families include Lamiaceae (22), Apiaceae (17), and Scrophulariaceae (15).

Of the 719 species reported for KWMA, 65 (9.04%) are considered to be non-native. This compares favorably with other wildlife management areas in Texas. For example, Mason Mountain WMA has 8.5 % of its flora introduced (Singhurst et al. 2007), while Gus Engeling WMA, of the Post Oak Savannah of the eastern part of the state, has 6.34 % introduced species (Singhurst et al. 2003). Diggs et al. (1999), reports 17.7% of the flora treated in their work (north central Texas) as non-native. The easily noticed trend is that the areas with a larger human population and more accessibility have a higher percentage of non-natives species present. Several of the non-natives present at KWMA may have been intentionally introduced as part of land management plans.

The following species, subspecies, and varieties documented to occur in KWMA, are considered endemic to the state of Texas (Correll & Johnston 1970; Carr 2008): *Agalinis edwardsiana*, *Argythamnia simulans*, *Astragalus wrightii*, *Brickellia eupatorioides* var. *gracillima*, *Buddleja racemosa* ssp. *incana*, *Carex edwardsiana*, *Chaetopappa bellidifolia*, *C. effusa*, *Clematis texensis*, *Euphorbia roemeriana*, *Galactia texana*, *Matelea edwardsensis*, *Monarda punctata* ssp. *punctata* var. *intermedia*, *Nolina lindheimeriana*, *Parthenocissus heptaphylla*, *Pediomelum hypogaeum* var. *scaposum*, *Penstemon triflorus* ssp. *triflorus*, *Phlox roemeriana*, *Physaria densiflora*, *P. recurvata*, *Sclerocactus brevihamatus* ssp. *tobuschii*, *Tradescantia edwardsiana*, *Tragia nigricans*, *Verbesina lindheimeri*, *Valerianella stenocarpa*, *Vitis monticola*, and *Yucca rupicola*.

Following are comments on unusual or interesting plant distributions.

Rhynchospora capillacea.—In Texas, this species is recorded only from Kerr Co. The nearest known occurrence is 355 miles to the north in the Soper Bog (Railroad Bog) in Choctaw County, Oklahoma. The

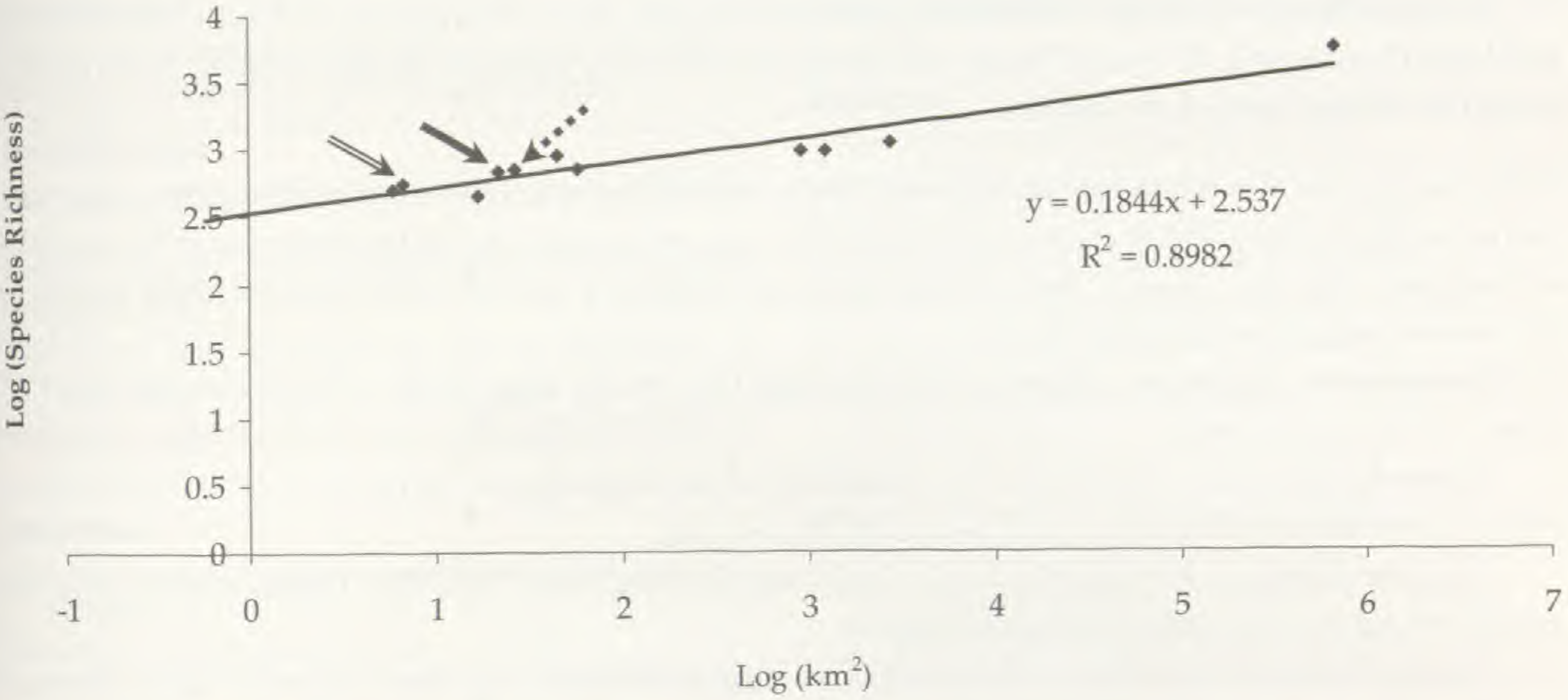

Fig. 2. Logarithmic relationship between species richness and geographic area represented by solid regression line. This regression indicates a relationship between species richness and geographic area explaining 89.88% of variation in species richness. Diamonds signify floristic inventories from Table 1, broken arrow indicates Kerr WMA, solid arrow designates Mason Mountain WMA, and double lined arrow points to Enchanted Rock State Natural Area.

Table 2. Comparison of Kerr WMA species richness for vascular plants and associated Sørenson coefficient calculated against published accounts and unpublished inventory in Texas, USA.

Region	Species number	Sørenson Similarity	Jaccard's Community Coefficient	Coefficient	Area (km2) Citation
Enchanted Rock SNA	555	.4694	.3067	6.7234	O'Kennon (unpub.)
Kerr WMA	719	–	–	26.6313	Singhurst et al. 2010
Mason Mountain WMA	693	.6388	.4693	21.6859	Singhurst et al. 2007

next location is in the northern Ozarks near the Missouri border. *Rhynchospora capillacea* is a fen specialist in the east and northeast United States. Apparently, the species requires cool running waters, here found on the Guadalupe River.

Asclepias verticillata.—Southwest limit of distribution, common in eastern half of Texas.

Fuirena squarrosa.—Approaching the western limit of distribution, but also few scattered records further west in the state (see Turner et al. 2003).

Hypoxis wrightii.—In Texas, known from few counties in the post oak savannahs and pinelands of the eastern quarter of the state.

Rudbeckia fulgida.—Presently limted to the pineywoods of east Texas, disjunct here (and in Gillespie Co.)

Agalinas homolantha.—Generally distributed in the eastern half of state, this being the western limit.

Vicia caroliniana.—An eastern species (previously known as far west as Travis and Comal cos.) that may possibly have been introduced as a wildlife food.

Physaria gracilis.—Generally distributed in north-central and east-central Texas, this being the western limit of the species.

Leptopus phyllanthoides.—In Texas, distributed along the eastern edge of the Balcones Escarpment from Johnson to Bexar cos., and also Val Verde Co. Elsewhere in southwest Missouri, northwest Arkansas, southeast Oklahoma, and central Alabama. In Texas, generally found on honeycombed limestone. Not often collected.

Boltonia diffusa.—In Texas, distributed in the Pineywoods, Poat Oak Savanna, and Gulf Coast Prairies and Marsh Ecoregoins. In central Texas, this species has been dcoumented in Hays County, with this this being the western limit of the species.

Following is a list of western species that reach their eastern limits in Kerr County. In general, these species occur in the Trans-Pecos vegetational region, the area of the state west of the Pecos River, occasionally referred to as "far west Texas." These records may only indicate a need for more intensive field studies in the western part of the Edwards Plateau.

Petrophytum caespitosum.—Also recorded for Real Co., on the west border of Kerr Co. and Frio Co., about 125 km to the south.

Echeandia flavescens.—This is the first record east of the Trans-Pecos. Turner et al. (2003) mapped the species as occurring in Brewster, Jeff Davis, and Presidio cos.

Dyssodia papposa.—A Trans-Pecos and Panhandle (Rolling Plains and High Plains) species with one record in Live Oak Co. of the Rio Grande Plains.

Pseudognaphalium canescens.—Also present as a disjunct in Llano Co., about 75 km to the northeast of Kerr Co.

Viguiera stenoloba.—Also known from the Rio Grande Plains, especially those counties adjoining the Rio Grande [River].

ANNOTATED CHECKLIST OF THE FLORA

The annotated checklist is divided into pteridophytes, gymnosperms, and angiosperms, which are subdivided into monocots and dicots. Family, genus, and species are arranged alphabetically beneath each major heading. Collectors and collection numbers are referenced as following: **CAM** = C.A. McMaham, **DH** = Donnie Harmel, **FG** = Frank Gould, **KW** = Kerr Wildlife Management Area staff, **MM** = Morton May, **JS** = Jason Singhurst, **LH** = Laura Hansen, **LS** = Laura Sanchez (earlier name for LH), **S&R** = D. Seigler & W. Renold, **TD** = Timery Debore, **TT** = Thomas Trinzie, and **AC** = Amy Choy. An asterisk (*) denotes an introduced species. Common names are included to facilitate ease of use by persons unfamiliar with botanical names.

PTERIDOPHYTES

Aspleniaceae

Asplenium resiliens Kunze; black stem spleenwort fern; JS 8473; 10592; 10627

Marsilaceae

Marsilea vestita Hook. & Grev. ssp. *vestita*; water clover fern; JS 10228

Pteridaceae

Adiantum capillus-veneris L.; southern maidenhair fern; JS 8500; 9970; LS 3843
Astrolepis integerrima (Hook.) Benham & Windham; hybrid cloakfern; LH 5860
Astrolepis sinuata (Lag. ex Sw.) Bentham & Windham ssp. *sinuata*; bulb lip fern; JS 18130
Cheilanthes alabamensis (Buckley) Kunze; Alabama lip fern; LS 3948
Cheilanthes horridula Maxon; rough lip fern; LH 5863
Cheilanthes tomentosa Link; woolly lip fern; JS 18003
Pellaea atropurpurea (L.) Link; purple cliffbrake fern; JS 10054; LS 3947
Pellaea ovata (Desv.) Weatherby; ovate leaf cliffbrake; JS 8771; 10055
Pellaea wrightiana Hook.; Hook's cliffbrake fern; JS 8490, 10058

Selaginellaceae

Selaginella wrightii Hieron.; Wright's spikemoss; JS 10044; LS 4106

Thelypteridaceae

Thelypteris ovata R.P. St. John var. *lindheimeri* (C. Chr.) A.R. Sm.; Lindheimer's maidenhair fern; JS 9971; LS 3836

GYMNOSPERMS

Cupressaceae

Juniperus ashei Buchh.; Ashe juniper; JS 18004; DH s.n.; FG 8288; LS 3812
Juniperus pinchotii Sudw.; Pinchot's juniper; JS 17205
Taxodium distichum (L.) Rich.; bald cypress; JS 17207

ANGIOSPERMS - Monocots

Agavaceae

Agave americana L.; American century plant; JS 18005
Dasylirion texanum Scheele; Texas sotol; JS 10563
Nolina lindheimeriana (Scheele) S. Wats.; devil's shoestring; JS 10574
Nolina texana S. Wats.; sacahuista; LH 4773
Yucca reverchonii Trel.; Plateau yucca; JS 10649
Yucca rupicola Scheele; Texas yucca; JS 10372

Bromeliaceae

Tillandsia recurvata (L.) L.; small ballmoss; JS 8770; LS 4086
Tillandsia usneoides (L.) L.; Spanish moss; JS 18006

Commelinaceae

Commelina erecta L.; white mouth dayflower; JS 18007; KW s.n.; LS 3785
Tinantia anomala (Torr.) C.B. Clarke; widow's tears; JS 10588; JS & TD 10701
Tradescantia edwardsiana Tharp; Plateau spiderwort; JS 10655; KW s.n.
Tradescantia gigantea Rose; giant spiderwort; JS 10655; JS & TD 10730

Cyperaceae

Carex edwardsiana Bridges & Orzell; Edwards Plateau sedge; JS 10582
Carex emoryi Dewey; Emory sedge; JS 17206
Carex perdentata S.D. Jones; little-tooth sedge; LS 3722; 4214
Carex planostachys Kunze; cedar sedge; JS & TD 10698; KW s.n.; LS 3753
Cladium mariscus (L.) Pohl ssp. *jamaicense* (Crantz) Kükenth.; Jamaica sawgrass; JS 9995; 9996; LS 3838
Cyperus acuminatus Torr. & Hook. ex Torr.; taperleaf flatsedge; JS 9997; LS 3923; 5311
Cyperus erythrorhizos Muhl.; red root; JS 10464
Cyperus flavescens L.; yellow flatsedge; JS 15970
Cyperus odoratus L.; fragrant flatsedge; JS 10760
Cyperus pseudothyrsiflorus (Kükenth.) J. Rich. Carter & S.D. Jones; flatsedge; LH 4979; 5318
**Cyperus rotundus* L.; nutgrass; JS 10223
Cyperus sphaerolepis Boeckeler; Rusby's flatsedge; LH 5320
Cyperus squarrosus L.; bearded flatsedge; JS 18011
Cyperus strigosus L.; false nutgrass; FG 8141; LS 4565
Eleocharis geniculata (L.) Roem. & Schult.; Canada spikesedge; JS 15963
Eleocharis montevidensis Kunth; sand spikesedge; JS 10220
Eleocharis palustris (L.) Roem. & Schult.; large spikesedge; JS 9974
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer; dwarf spikesedge; JS 18008
Eleocharis rostellata (Torr.) Torr.; beaked spikerush; JS 15960
Fimbristylis puberula (Michx.) Vahl; hairy fimbry; JS 10640; LH 4986
Fuirena simplex Vahl; western umbrella sedge; JS 9975; LS 3929; LH 4987
Fuirena squarrosa Michx.; hairy umbrella sedge; JS 8498
Rhynchospora capillacea Torr.; horned beakrush; JS 15964
Rhynchospora colorata (L.) H. Pfeiffer; star rush whitetop; JS 9965; LS 3864
Rhynchospora nivea Boeck.; snowy white top sedge; JS 8499; 9964; 15965; LS 3845
Schoenus nigricans L.; black bogrush; JS 18009
Scleria verticillata Muhl. ex Willd.; low nutrush; JS 15973; LS 4100

Iridacerae

Sisyrinchium chilense Hook.; sword leaf blue-eyed grass; JS & TD 10739; KW s.n.; LH 4785
Sisyrinchium langlosii Greene; pale blue-eyed grass; JS & TD 10740

Juncaceae

Juncus dichotomus Ell.; forked rush; LH 5312
Juncus interior Wieg.; inland rush; LS 4212
Juncus marginatus Rostk.; grassleaf rush; JS 10031
Juncus scirpoides Lam.; needlepod rush; JS 10460
Juncus texanus (Engelm.) Coville; Texas rush; JS 15975
Juncus torreyi Coville; Torrey's rush; LH 4988
Juncus validus Coville var. *fascinatus* M.C. Johnston; roundhead rush; JS 10638

Liliaceae

Allium canadense L.; Canada garlic; JS 10449; JS & TD 10707
Allium drummondii Regel; Drummond onion; JS 10387; JS & TD 10708; KW s.n.; LH 4762
Cooperia drummondii Herb.; cebolleta; LS 3945
Cooperia pedunculata Herb.; giant rain lily; JS 10064; 10433; JS & TD 10700; LS 3793
Echeandia flavescens (J.A. & J.H. Schultes) Cruden; Torrey's craglily; JS 18010
Hypoxis wrightii (Baker) Brackett; Wright's star-grass; LH 4982
Nothoscordum bivalve (L.) Britt.; crow poison; JS 10045; KW s.n.; LS 4541
Schoenocaulon drummondii A. Gray; green lily; JS 10392; 10576
Schoenocaulon texanum Scheele; Texas sabadilla; LH 4771

Najadaceae

Najas guadalupenis (Spreng.) Magnus; southern naiad; JS 15966

Orchidaceae

Epipactis gigantea Dougl. ex Hook; giant helleborine orchid; JS 9969; 10566; LH 4985
Spiranthes magnicamporum Sheviak; ladies' tresses orchid; JS 18012

Poaceae

**Aegilops cylindrica* Host; jointed goat grass; LS 3763
Andropogon gerardii Vitman; big bluestem; JS 18013; KW s.n.; LS 4117
Andropogon glomeratus (Walt.) B.S.P.; bushy bluestem; JS 10004; 10033; FG 8159; LS 4116
Aristida oligantha Michx.; oldfield threeawn; JS 10626; FG 8258; LS 3910
Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey; red threeawn; LS 3757; 4409
Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred; blue threeawn; LS 4053; 4560
Aristida purpurea Nutt. var. *purpurea*; purple threeawn; JS 10422; FG 8259; LS 4411
Aristida purpurea Nutt. var. *wrightii* (Nash) Allred; Wright's threeawn; JS 10579*b*; FG 8266; LS 4410; LH 5030
Bothriochloa barbinodis (Lag.) Herter var. *barbinodis*; cane bluestem; JS 10674; 10458; KW s.n.
Bothriochloa barbinodis (Lag.) Herter var. *perforata* (Trin. ex Fourn.) Gould; pinhole bluestem; LS 3912
**Bothriochloa ischaemum* (L.) Keng var. *songarica* (Rupr. ex

Fisch. & Mey.) Celarier & Harlan; King Ranch bluestem; JS 10006; KW s.n.; LS 3768; LH 5310

Bothriochloa laguroides (DC.) Herter ssp. _torreyana_ (Steud.) Allred & Gould; silver bluestem; JS 10007; 10667; KW s.n.; FG 8278; LS 3765; 4407

Bouteloua barbata Lag.; sixweeks grass; JS 10226_a_

Bouteloua curtipendula (Michx.) Torr. var. _caespitosa_ Gould & Kap.; sideoats grama; JS 10584; FG 8289; MM 5514; LS 3907

Bouteloua curtipendula (Michx.) Torr. var. _curtipendula_; side oats grama; JS 9979; FG 8289; LS 3906

Bouteloua hirsuta Lag.; hairy grama; FG 8262; 8451; 8452; LS 3918

Bouteloua rigidiseta (Steud.) Hitchc. var. _rigidiseta_; Texas grama; JS 10397; FG 8284; LS 3762

Bouteloua pectinata Featherly; tall grama; LS 4543

Bouteloua trifida Thurb.; red grama; FG 8453; 8281; LS 4047

Bouteloua uniflora Vasey; Neally grama; FG 8255; MM 5520

*_Bromus arvensis_ L.; Japanese brome; JS 10404; JS & TD 10728; LS 3124; 3724

*_Bromus cartharticus_ Vahl; rescue grass; JS 10391; FG 8307; LS 3723

Bromus pubescens Muhl. ex Wild.; hairy brome; JS & TD 10729

*_Bromus tectorum_ L. var. _tectorum_; cheat grass; JS & TD 10727; KW s.n.

Buchloe dactyloides (Nutt.) Engelm.; buffalo grass; JS 10473; FG 8303; LS 3731

Cenchrus spinifex Cav.; common sand bur; JS 9953; FG 8280; LS 4536

Chloris andropogonoides Fourn.; slimspike windmill grass; FG 8295; LS 3766

Chloris cucullata Bisch.; hooded windmill grass; JS 10677

Chloris subdolichostachya Muell.; short-spike windmill grass; LS 4406

Chloris verticillata Nutt.; tumble windmill grass; JS 10424; LS 3784; 3911; 4114

*_Cynodon dactylon_ (L.) Pers.; bermuda grass; JS 10676; LS 3751

*_Desmazeria rigida_ (L.) Tutin; cat grass; JS 10630; LS 3774

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. _acuminatum_; woolly rosette grass; LS 3844

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. _lindheimeri_ (Nash) Gould & C.A. Clark; Lindheimer panicgrass; JS 15971

Dichanthelium oligosanthes (Schult.) Gould var. _scribnerianum_ (Nash) Gould; Scribner's rosette grass; LS 3797

Dichanthelium pedicellatum (Vasey) Gould; cedar rosette grass; FG 8262; 8454

Digitaria californica (Benth.) Henr.; Arizona cottontop; KW s.n.

Digitaria ciliaris (Retz.) Koeler; southern crabgrass; LS 4090

Digitaria cognata (Schult.) Pilger; fall witchgrass; FG 8252

Digitaria pubiflora (Vasey) Wipff; Carolina crabgrass; LS 4113; LH 5018

*_Echinochloa colona_ (L.) Link; Jungle rice; JS 10456; FG 8298; LS 3924; 4091; 4566

*_Echinochloa walteri_ (Pursh) A. Heller; Coast cockspur; JS 10675

Elymus canadensis L. _canadensis_; Canada wildrye; KW s.n.; LS 3783

Elymus virginicus L.; Virginia wildrye; JS 10437; LS 3855

*_Eragrostis barrelieri_ Daveau; Mediterranean love grass; LS 4085

*_Eragrostis cilianensis_ (All.) Vign. ex Janchen.; stinkgrass; JS 10461; FG 8467; 8309; LS 4051; 4068

Eragrostis curtipedicellata Buckley; gummy lovegrass; LS 3934; 3957

Eragrostis intermedia Hitchc.; plains lovegrass; FG 8287; KW s.n.; LS 3909; 4108

Eragrostis lugens Nees; mourning lovegrass; FG 8287

Eragrostis pectinacea Michx.) Nees ex Steud.; tufted lovegrass; JS 10226_b_

*_Eragrostis superba_ Peyr.; Wilmann's lovegrass; LH 5319

Eriochloa contracta Hitchc.; prairie cupgrass; FG 8300

Eriochloa sericea (Scheele) Munro ex Vasey; Texas cupgrass; KW s.n.; LS 3798

Erioneuron pilosum (Buckley) Nash; hairy erioneuron; JS 10403; JS & TD 10725; LS 3756

Hilaria belangeri (Steud.) Nash.; common curly mesquite; JS 10043; FG 8243; LS 3914

Hordeum jubatum L.; foxtail barley; FG 8274

Hordeum pusillum Nutt.; little barley; JS 10471; LS 3727

*_Hordeum vulgare_ L.; barley; JS 10443

Leersia oryzoides (L.) Sw.; rice cutgrass; JS 18014

Leptochloa dubia (Kunth.) Nees; green sprangletop; JS 10445; 10610; KW s.n.; LS 4077

Leptochloa panicea (Retz.) Ohwi ssp. _mucronata_ (Michx.) Nowack; red sprangletop; JS 10468; KW s.n.

Limnodea arkansana (Nutt.) L.H. Dewey; Ozark grass; JS & TD 10755; KW s.n.; LS 3729

*_Lolium perenne_ L.; perennial ryegrass; JS 10459; 10797; LH 5028

Melica nitens (Scribn.) Nutt. ex Piper; three flower melic; JS 10450; 10590; KW s.n.; LS 3870

Muhlenbergia lindheimeri Hitchc.; Lindheimer muhly; JS 10005; 10062; LS 4118

Muhlenbergia reverchonii Vasey & Scribn.; seep muhly; JS & TD 10733; KW s.n.; MM 5515; LS 4079

Muhlenbergia schreberi J.F. Gmel.; nimblewill muhly; JS 10577

Muhlenbergia utilis (Torr.) Hitchc.; aparejograss; JS 15961

Nassella leucotricha (Trin. & Rupr.) Pohl; Texas winter-grass; JS 10421; 10578; FG 8270; LS 3728

Panicum capillare L.; common witchgrass; JS 10408

*_Panicum coloratum_ L.; Klein grass; LS 3846; 3942; 4568

Panicum dichotomiflorum Michx.; fall panicum; JS 10224

Panicum diffusum Sw.; spreading panicum; JS 10579_a_

Panicum hallii Vasey var. _hallii_; Halls panicum; JS 10677; FG 8249; LS 4050; 4416; 4532

Panicum hians Ell.; gaping panicum; JS 18015

Panicum obtusum Kunth; vine mesquite; JS 10600; FG 8272; LS 3908; 3956

Panicum virgatum L.; switchgrass; JS 9985; FG 8470; LS 3927

*_Paspalum dilatatum_ Poir.; dallisgrass; JS 10446; KW s.n.; LS 3833

Paspalum distichum L.; knot grass; LH 5313

Paspalum pubiflorum Rupr. ex Fourn. var. *pubiflorum*; hairyseed paspalum; JS 10668; LS 4546

Paspalum setaceum Michx.; thin paspalum; JS 10595

**Paspalum urvillei* Steud.; vasseygrass; JS 10606; LS 3832

Phalaris caroliniana Walt.; Carolina canarygrass; JS 10466

**Poa annua* L.; annual bluegrass; JS 18016; LS 3717

**Polypogon monspeliensis* (L.) Desf.; rabbitfoot panicum; JS 10598; LS 3871

**Polypogon viridis* (Gouan) Breistr.; water bent grass; LS 3839

Schedonnardus paniculatus (Nutt.) Trel.; tumblegrass; FG 8296; LS 3764

**Schedonorus phoenix* (Scop.) Holub; tall fescue; LS 3847

Schizachyrium scoparium (Michx.) Nash var. *scoparium*; little bluestem; JS 9986; FG 8259; LS 4107

Setaria leucopila (Scribn. & Merr.) K. Schum.; streambed bristlegrass; LS 4554; LH 5021

Setaria parviflora (Poir.) Kerguelen; knot-root bristlegrass; JS 18017; FG 9292

Setaria scheelei (Steud.) Hitchc.; southwestern bristlegrass; FG 8469; MM 5516; LS 4081; 4551

Sorghastrum nutans (L.) Nash; yellow Indiangrass; JS 10022; KW s.n.; LS 4112

**Sorghum halapense* (L.) Pers.; Johnson grass; JS 10008; FG 8279; LS 3848

Sphenopholis obtusata (Michx.) Scribn. var. *obtusata*; prairie wedgescale; JS 18018

Sporobolus compositus (Poir.) Merr. var. *compositus* (Trin.) Kartesz & Gandhi; composite dropseed; JS 10032; KW *s.n*; LS 4048; 4109; 4539; 4544; 4555

Sporobolus cryptandrus (Torr.) A. Gray; sand dropseed; FG 8264; LS 4052

Sporobolus neglectus Nash; puffsheath dropseed; LS 4110

Sporobolus ozarkanus Fernald; Ozark dropseed; LS 4552; 4570

Sporobolus pyramidatus (Lam.) Hitchc.; whorled dropseed; JS 10651

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood; poverty dropseed; JS 9951; FG 8450

**Stenotaphrum secundatum* (Walt.) Kuntze; St. Augustine grass; JS 10596; LH 5316

Tridens albescens (Vasey) Woot. & Standl.; white tridens; JS 18019; FG 8277; LS 3767

Tridens eragrostoides (Vasey & Scribn.) Nash ex Small; lovegrass tridens; LS 4122

Tridens muticus (Torr.) Nash; slim tridens; JS 10753; FG 8482; LS 4049

Tripsacum dactyloides (L.) L.; eastern gammagrass; JS 9958; 10553; LS 3831

Trisetum interruptum Buckley; prairie trisetum; KW s.n.; MM 5541

Urochloa fusca (Sw.) B.F. Hansen & Wunderlin; brown-top signal grass; FG 8297; LS 4084; LH 5024

Vulpia octoflora (Walt.) Rydb.; sixweeksgrass; JS & TD 10405; 10724; KW s.n.; LS 4206

Pontederiaceae

Heteranthera dubia (Jacq.) MacM.; grassleaf mudplantain; JS 9963*a*

Heteranthera limosa (Sw.) Willd.; blue mud plantain; LS 3959

Potamogetonaceae

Potamogeton diversifolius Raf.; waterthread pondweed; JS 18020

Potamogeton nodosus Poir.; long leaf pondweed; JS 9981; LH 5952

Smilacaceae

Smilax bona-nox L.; saw greenbrier; JS 9960; 10585; KW s.n.; LS 3806

Typhaceae

Typha latifolia L.; common cattail; JS 18021

ANGIOSPERMS - Dicots

Acanthaceae

Carlowrightia texana Hendrick. & Daniel; carlowrightia; JS 18022

Dicliptera brachiata (Pursh) Spreng.; dicliptera; JS 18023

Dyschoriste linearis (Torr. & A. Gray) Kuntze; narrow leaf dysochriste; JS 18024

Justicia americana (L.) Vahl; American water willow; JS 10549; LS 3842

Ruellia metziae Tharp; Metz's wild petunia; LS 4041

Ruellia nudiflora (Engelm. & A. Gray) Urban var. *nudiflora*; violet ruellia; JS 18025

Aizoaceae

Trianthema portulacastrum L.; horse purslane; KW s.n.

Amaranthaceae

**Alternanthera caracasana* Kunth; chaff flower; FG 8292; LS 4418

**Amaranthus albus* L.; tumbleweed amaranth; JS 10624; KW s.n.; LS 4072

**Amaranthus blitoides* S. Wats.; prostrate pigweed; LS 4564

Amaranthus palmeri S.Wats.; carelessweed; JS 18026

Amaranthus polygonoides L.; tropical amaranth; LS 4534

Amaranthus retroflexus L.; green amaranth; LS 4082

Amaranthus rudis Sauer; amaranth; JS 18027

Gossypianthus lanuginosus (Poir.) Moq.; cotton flower; LS 4419

Anacardiaceae

Rhus glabra L.; smooth sumac; JS 10442; KW s.n.

Rhus lanceolata (A. Gray) Britt.; prairie sumac; CAM 16b; DH s.n.; LS 3921; LH 5321

Rhus microphylla Engelm.; little-leaf sumac; JS 18028

Rhus trilobata Nutt.; skunkbush sumac; LS 4217; JS 18029; DH s.n.; CAM 51b; KW s.n.

Rhus virens Lindh. ex A. Gray ssp. *virens*; evergreen sumac; JS 10010; KW s.n.; LS 4123

Toxicodendron radicans (L.) Kuntze; poison oak; JS 18030; LS 4218

Apiaceae

Berula erecta (Huds.) Coville; cutleaf waterparsnip; JS 17208

Bifora americana Benth. & Hook. f. ex S. Wats.; prairie bishop; JS 18031

Bowlesia incana Ruiz & Pav.; hoary bowlesia; JS & TD 10703

Centella asiatica (L.) Urban; spadeleaf; JS 10013; 10616; LS 4414; LH 4984

Chaerophyllum tainturieri Hook. var. *tainturieri*; chervil; JS & TD 10706; KW s.n.; LS 3780

Cicuta maculata L.; spotted water hemlock; JS & TD 10712; LS 3928

**Conium maculatum* L.; poison hemlock; JS 10639

**Cyclospermum leptophyllum* (Pers.) Sprague ex Britt. & P. Wilson; slim-lobe celery; LS 3858

Daucus pusillus Michx.; southwestern carrot; JS 10407; LS 3746

Hydrocotyle prolifera Kellogg; whorled water pennywort; LS 3863

Hydrocotyle verticillata Thunb.; water pennywort; JS 10014; 10602

Polytaenia texana (J.M. Coult. & Rose) Mathias & Constance; prairie parsnip; JS 10642

Ptilimnium capillaceum (Michx.) Raf.; herbwilliam; JS 10418

Sanicula canadensis L.; Canada sanicle; JS 10444

Spermolepis divaricata (Walter) Raf. ex Ser.; forked scaleseed; LH 5019

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance; spreading scaleseed; JS & TD 10711; LS 3779; 3790; 3859

**Torilis arvensis* (Huds.) Link; hedge parsley; JS 10400; KW s.n.; LS 3735

Apocynaceae

Apocynum cannabinum L.; dogbane; JS 10669

Asclepias asperula (Decne.) Woodson; trailing milkweed; JS 10371; TT & AC 147; LS 4056

Asclepias oenotheroides Cham. & Schltdl.; hierba de zizotes; JS 10678; LS 4549

Asclepias texana A. Heller; Texas milkweed; JS 10057; 10561; LS 4104

Asclepias verticillata L.; whorled milkweed; JS 10652

Asclepias viridiflora Raf.; green antelope horn; JS 10677; KW s.n.

Cynanchum racemosum (Jacq.) Jacq. var. *unifarium* (Scheele) Sundell; talayote; LH 5023

Funastrum crispum (Benth.) Schltr.; wavyleaf twinevine; JS 18032; KW s.n.

Matelea biflora (Raf.) Woods.; two-flower milkvine; JS 18033; LS 4058

Matelea edwardsensis Correll; plateau milkvine; JS 18034

Matelea gonocarpos (Walt.) Shinners; angular-fruit milkvine; JS 18035

Matelea reticulata (Engelm. ex A. Gray) Woods.; net-vein milkvine; LS 3755

Aquifoliaceae

Ilex decidua Walt.; deciduous holly; LS 4220

Aristolochiaceae

Aristolochia coryi I.M. Johnst.; Cory dutchman's pipe; JS 10053; FG 8761; LS 3854; 3935

Aristolochia serpentaria L.; dutchman's pipe; JS 10586; LS 3841; 4221

Asteraceae

Achillea millefolium L.; western yarrow; JS 18036

Ageratina altissima (L.) King & H. Rob.; white snakeroot; JS 8494

Ageratina havanensis (Kunth) King & H.E. Robins.; Havana snakeroot; JS 8475; 10594; LS 3869; 4561

Ambrosia artemisiifolia L.; common ragweed; JS 10050

Ambrosia confertiflora DC.; field ragweed; FG 8201; LS 4531; S&R 928

Ambrosia psilostachya DC.; western ragweed; JS 18037; LS 4562

Amphiachyris dracunculoides (DC.) Nutt.; broomweed; JS 18038

Aphanostephus ramosissimus DC. var. *ramosissimus*; plains lazy daisy; FG 8271; 8304; LS 3801; LH 4779; 5020

Aphanostephus skirrhobasis (DC.) Trel. var. *skirrhobasis*; Arkansas lazy daisy; JS 10420

Artemisia ludoviciana Nutt.; Louisiana sagewort; JS 18039; LS 4548

Baccharis neglecta Britton; Roosevelt-weed; LS 4119; 4540

Baccharis salicina Torr & A. Gray; seepwillow; KW s.n.

Baccharis texana (Torr. & A. Gray.) A. Gray; prairie weed; JS 8487; 9950

Berlandiera betonicifolia (Hook.) Small; Texas greeneyes; JS 10380; 10644

Bidens bipinnata L.; Spanish needles; JS 10819

Bidens laevis (L.) Britton, Sterns & Poggenb.; smooth beggartick; JS 15971; LS 4557

Boltonia diffusa Elliot; smallhead doll's daisy; JS 15969

Brickellia cylindracea A. Gray & Engelm.; brickell bush; LS 4095

Brickellia eupatorioides (L.) Shinners var. gracillima (A. Gray) B.L. Turner; false boneset; JS 9983

Calyptocarpus vialis Less.; prostrate lawnflower; JS 10641; LS 3952

**Carduus nutans* L. var. *macrocephalus* (Desf.) Boivin; musk-thistle; JS 10556; LS 3742; LH 5323

**Carduus tenuiflorus* W. Curtis; slender bristlethistle; JS & TD 10732

Centaurea americana Nutt.; American basket flower; JS 10643

**Centaurea melitensis* L.; Malta centaurea; JS & TD 10720; KW s.n.; LS 3741

Chaetopappa asteroides Nutt. ex DC.; common least daisy; JS 9952; KW s.n.

Chaetopappa bellidifolia (A. Gray & Engelm.) Shinners; hairy least daisy; JS 10423; KW s.n.; LS 3787; LH 4776; 4991

Chaetopappa effusa (A. Gray) Shinners; spreading least daisy; JS 8495

Chaptalia texana Greene; nodding lettuce; JS 10646

Chrysactinia mexicana A. Gray; damianita; LS 3802

Cirsium ochrocentrum A. Gray; yellow spine thistle; JS 10455

Cirsium texanum Buckley; southern thistle; JS 10556; KW s.n.; LS 3760

Cirsium undulatum (Nutt.) Spreng.; wavyleaf thistle; JS 10386

**Cirsium vulgare* (Savi) Ten.; bull thistle; LH 5027

Conyza canadensis (L.) Cronq. var. *glabrata* (A. Gray) Cronq.; Canada fleabane; JS 18040; KW s.n.; LS 4073

Conyza ramosissima Cronq.; low conyza; FG 8304

Coreopsis basilis (Dietr.) Blake; goldenmane coreopis; JS 10428; 10573; KW s.n.

Coreopsis tinctoria Nutt. var. *tinctoria*; plains coreopsis; JS & TD 10695

Dracopis amplexicaulis (Vahl) Cass.; clasping coneflower; JS 10617

Dyssodia papposa (Vent.) Hitchc.; mayweed dogweed; JS 18041

Eclipta prostrata (L.) L.; Yerba de Tago; JS 18131

Engelmannia peristenia (Raf.) Goodman & C.A. Lawson; Engelmann's daisy; LH 4977

Erigeron modestus A. Gray; plains fleabane; JS 18042; 10546; KW s.n.; LS 3800

Eupatorium serotinum Michx.; late eupatorium; JS 8483; 9968; LS 4096

Evax prolifera Nutt. ex DC.; bighead evax; JS 10398; KW s.n.; LS 3769; LH 4778

Evax verna Raf.; many-stem evax; JS 10406; LH 4777

Gaillardia pulchella Foug. var. *pulchella*; firewheel; JS 10414; KW s.n.; LS 3748

Gaillardia suavis (A. Gray & Engelm.) Britt. & Rusby; small ray firewheel; JS 10394; LH 4770

Gamochaeta purpurea (L.) Cabrera; cudweed; JS 10048

Grindelia squarrosa (Pursh) Dunal; curly-cup gumweed; JS 18043

Gutierrezia texana (DC.) Torr. & A. Gray var. *texana*; Texas broomweed; JS 18044; FG 8243; LS 4537

Helenium amarum (Raf.) H. Rock var. *badium* (A. Gray ex S. Watson) Waterf.; basin sneezeweed; JS 18045

Helenium elegans DC.; common sneezeweed; JS 10603

Helenium microcephalum DC. var. *microcephalum*; smallhead sneezeweed; JS 10454; LH 5033

Helianthus annuus L.; common sunflower; FG s.n.; KW s.n.; LH 5317

Helianthus maximiliani Schrad.; Maximillian sunflower; JS 10672; LS 3932

Heterotheca subaxillaris (Lam.) Britt. & Rusby; camphorweed; JS 18046; KW *s.n.*

Hymenopappus scabiosaeus L'Her.; flat-top woolly white; JS 10042; 10448; LH 4974

Krigia caespitosa (Raf.) Chamb.; weedy dwarf dandelion; JS 18047

Lactuca canadensis L. var. *canadensis*; Canada lettuce; JS 10558

Lactuca ludoviciana (Nutt.) Riddell; western wild lettuce; LH 5026

**Lactuca serriola* L.; prickly lactuca; KW s.n.

Laennecia coulteri (A. Gray) G.L. Nesom; Coulter conyza; FG 8217

Liatris mucronata DC.; blazing star; JS 10066

Lindheimera texana A. Gray; Texas star; JS 10447

Lygodesmia texana (Torr. & A. Gray) Greene; Texas skeleton plant; JS 10656; LH 4992

Marshallia caespitosa Nutt. ex DC. var. *signata* Beadle & F.E. Boynt.; Barbara's button; JS 10436

Melampodium leucanthum Torr. & A. Gray; plains blackfoot; JS 18048; KW s.n.; LS 3943

Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Löve; roundleaf ragwort; JS & TD 10718

Packera plattensis (Nutt.) W.A. Weber & A. Löve; prairie groundsel; JS & TD 10719; KW s.n.

Palafoxia callosa (Nutt.) Torr. & A. Gray; palafoxia; JS 10065

Parthenium hysterophorus L.; false ragweed; LS 4076; LH 5031

Perityle lindheimeri (A. Gray) Shinners; Lindheimer rock daisy; JS 8479; 10635; LS 3851

Pinaropappus roseus (Less.) Less.; white rock lettuce; JS & TD 10743; KW s.n.; LH 4769

Pluchea odorata (L.) Cass.; purple stinkweed; JS 18049

Pseudognaphalium canescens (DC.) W.A. Weber; Wright cudweed; JS 8476

Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt; fragrant cudweed; JS 10227

Psilostrophe tagetina (Nutt.) Greene; paper flower; JS 8496

Pyrrhopappus carolinianus DC.; false dandelion; JS 10425

Pyrrhopappus pauciflorus (D. Don) DC.; many-stem false dandelion; KW s.n.

Ratibida columnifera (Nutt) Woot. & Standl.; Mexican hat; JS 10389; JS & TD 10696; LS 3773

Ratibida tagetes (James) Barnh.; short-ray prairie coneflower; JS 10601

Rudbeckia fulgida Aiton; orange coneflower; JS 17577

Rudbeckia hirta L. var. *pulcherrima* Farw.; black-eyed Susan; LH 5315

Silphium radula Nutt.; roughstem rosinweed; JS 10604

Simsia calva (Engelm. & A. Gray) A. Gray; awnless bush sunflower; KW s.n.; LS 4055

Solidago altissima L.; common goldenrod; JS 9972

Solidago juliae G.L. Nesom; Julia's goldenrod; LS 4115

Solidago nemoralis Aiton; oldfield goldenrod; JS 9998; LS 4550

Solidago petiolaris Aiton; goldenrod; JS 9973

Solidago radula Nutt.; rough goldenrod; JS 10568

**Sonchus asper* (L.) Hill; prickly sowthistle; JS 8501; 10431

Symphyotrichum divaricatum (Nutt.) G.L. Nesom; hierba del marrano; JS 10000

Symphyotrichum drummondii (Lindl.) G.L. Nesom var. *texanum* (Burgess) G.L. Nesom; Texas aster; JS 10225

Symphyotrichum ericoides (L.) G.L. Nesom; heath aster; JS 18050

Symphyotrichum patens (Aiton) G.L. Nesom var. *patens*; skydrop aster; JS 18051

Symphyotrichum praealtum (Poir.) G.L. Nesom var. *praealtum*; willow-leaf aster; JS 15962; LS 4120; 4558

Symphyotrichum sericeum (Vent.) G.L. Nesom; silky aster; JS 18052

**Taraxacum officinale* F.H. Wiggers; common dandelion; JS 10388; LH 5580

Tetragonotheca texana Engelm & A. Gray ex A. Gray; Plateau nerve ray; FG 8245; LS 3936

Tetraneuris acaulis (Pursh) Greene; stemless four-nerve daisy; KW s.n.

Tetraneuris linearifolia (Hook.) Greene; fineleaf fournerved daisy; JS 10379; FG 8216; LS 3737

Tetraneuris scaposa (DC.) Greene; stemmy fournerved daisy; JS & TD 10722; LS 3941
Thelesperma filifolium (Hook.) A. Gray; greenthread; LS 3749
Thelesperma megapotamicum (Spreng.) Kuntze; Hopi tea greenthread; JS 10385
Thelesperma simplicifolium A. Gray; slender greenthread; LS 3803
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray; cowpen daisy; JS 8482; LS 3931
Verbesina lindheimeri B.L. Rob. & Greenm.; Lindheimer's crownbeard; JS 15974
Verbesina virginica L.; frostweed; JS 9991; LS 4101
Vernonia lindheimeri A. Gray & Engelm. ex A. Gray; ironweed; JS 18053
Viguiera stenoloba Blake; resin bush; LS 3940; 4569
Wedelia texana (A. Gray) B.L. Turner; orange zemenia; JS 18054; FG 8231; 8263; LS 4062
**Xanthium spinosum* L.; spiny cocklebur; FG 8348
Xanthium strumarium L.; abrojo; JS 18055

Berberidaceae

Mahonia trifoliolata (Moric.) Fedde; algerita; JS 18056; KW s.n.; LS 4193

Boraginaceae

**Buglossoides arvensis* (L.) I.M. Johnst.; heliotrope; KW s.n.
Heliotropium tenellum (Nutt.) Torr.; pasture heliotrope; JS 10029; FG 8147; LS 3902
Lithospermum incisum Lehm.; narrowleaf gromwell; JS 18057; KW s.n.

Brassicaceae

**Capsella bursa-pastoris* (L.) Medik.; shepherd's purse; JS 18058; LS 3720
Draba cuneifolia Nutt. ex Torr. & A. Gray; wedgeleaf whitlowgrass; JS 18059; KW s.n.; LH 4763
Draba platycarpa Torr. & A. Gray; broadpod whitlowgrass; JS 18060; KW s.n.; LH 4758
Draba reptans (Lam.) Fernald; Carolina draba; JS & TD 10684; KW s.n.
Lepidium austrinum Small; southern pepperweed; LS 3721; 4042
Lepidium virginicum L.; Virginia pepperweed; JS & TD 10744; KW s.n.; LH 4772
**Nasturtium officinale* W.T. Aiton; watercress; LH 4981
Physaria argyraea (A. Gray.) O'Kane & Al-Shehbaz; silvery bladderpod; KW s.n.
Physaria densiflora (A. Gray) O'Kane & Al-Shehbaz; denseflower bladderpod; JS & TD 10745
Physaria gracilis (Hook.) O'Kane & Al-Shehbaz ssp. *gracilis*; white bladderpod; LS 4207
Physaria recurvata (A. Gray) O'Kane & Al-Shehbaz.; gaslight bladderpod; slender bladderpod; LS 3738; LH 4759
Rorippa sessiliflora (Nutt.) Hitchc.; stalkless yellowcress; JS 10664

Cactaceae

Coryphantha sulcata (Engelm.) Britt. & Rose; pineapple cactus; LH 5956
Cylindropuntia imbricata (Haw.) F.M. Knuth; tree cholla; JS 18061
Cylindropuntia leptocaulis (DC.) F.M. Knuth; pencil cactus; JS 10441
Echinocactus texensis Hopffer; devil's pincushion cactus; JS 18062; LS 4208
Echinocereus enneacanthus Engelm.; pitaya; JS 18063
Echinocereus reichenbachii (Terscheck ex Walp.) Haage ssp. *reichenbachii*; lace cactus; JS 18064
Echinocereus triglochidiatus Engelm.; claret cup cactus; LS 4216
Epithelantha micromeris (Engelm.) A. Weber; button cactus; LS 3946
Mammillaria heyderi Muehlenpfordt; little nipple cactus; LH 5626
Opuntia edwardsii V.E. Grant & K.A. Grant; Edwards prickly pear; JS 18065
Opuntia engelmannii Salm-Dyck ex Engelm. var. *lindheimeri* (Engelm.) Parfitt & Pinkava; Texas prickly pear; JS 18066; LH 5868
Opuntia macrorhiza Engelm.; plains prickly pear; LH 5870
Opuntia phaeacantha Engelm. var. *major* Engelm.; brownspine prickly pear; LH 5869
Sclerocactus brevihamatus (Engelm.) D.R. Hunt ssp. *tobuschii* (W.T. Marsh.) N.P. Taylor; Tobusch fish-hook cactus; photo only (Listed as Endangered)

Campanulaceae

Lobelia cardinalis L. var. *cardinalis*; cardinal flower; JS 18067
Triodanis coloradoensis (Buckley) McVaugh; Colorado Venus looking glass; JS 10416; 10580; KW s.n.
Triodanis lamprosperma McVaugh; prairie Venus looking glass; KW s.n.
Triodanis perfoliata (L.) Neiuwl.; Venus looking glass; JS 10375; KW s.n.

Capparidaceae

Polanisia dodecandra (L.) DC.; clammyweed; JS 10615; 10654; LS 4071

Caprifoliaceae

Lonicera albiflora Torr. & A. Gray; white honeysuckle; JS & TD 10741; KW s.n.; LS 4204
Symphoricarpos orbiculatus Moench; coralberry; JS 18068; LS 4556
Viburnum rufidulum Raf.; downy viburnum; JS 10021; 10547; JS & TD 10726; KW s.n.

Caryophyllaceae

Arenaria benthamii Fenzl. ex Torr. & A. Gray; hilly sandwort; JS 18069; LS 3730
**Cerastium glomeratum* Thuillier; chickweed; JS 18070
Paronychia lindheimeri Engelm. ex A. Gray; Lindheimer's nailwort; LS 4567
Paronychia virginica Spreng.; bristle nailwort; JS 18071
**Polycarpon tetraphyllum* (L.) L.; fourleaf manyseed; JS 18072
Silene antirrhina L.; sleepy catchfly; JS 10417; LS 3732
**Stellaria media* (L.) Vill.; chickweed; JS & TD 10702

Chenopodiaceae

Chenopodium album L. var. *album*; pigweed; JS 18073; LH 4976
Chenopodium berlandieri Moq.; pitseed goosefoot; KW s.n.

Chenopodium simplex (Torr.) Raf.; maple-leaf goosefoot; LS 4088

Clusiaceae

Hypericum drummondii (Grev. & Hook.) Torr. & A. Gray; Drummond St. John's wort; JS 18074

Hypericum mutilum L.; dwarf St. John's wort; JS 18075

Convolvulaceae

**Convolvulus arvensis* L.; field bindweed; JS 10384

Convolvulus equitans Benth.; gray bindweed; JS 10673; LS 3778

Dichondra carolinensis Michx.; grass pony weed; JS 10390; LS 4210

Evolvulus sericeus Sw.; silver dwarf morning glory; JS 18076; LS 3916

Ipomoea cordatotriloba Dennst. var. *cordatotriloba*; sharp-pod morning glory; LS 3958

Ipomoea hederacea Jacq.; ivy-leaf morning glory; JS 8489

Ipomoea lindheimeri A. Gray; Lindheimer's morning glory; LS 4060

Ipomoea purpurea (L.) Roth; Mexican morning glory; JS 10411

Cornaceae

Cornus drummondii C.A. Mey.; roughleaf dogwood; JS 10589; KW s.n.; LH 5867

Crassulaceae

Crassula aquatica (L.) Schoenl.; crassula; JS 18077

Sedum nuttallianum Raf.; Nuttall's stonecrop; JS 10463; LS 3794

Cucurbitaceae

Cucurbita foetidissima Kunth. in H.B.K.; buffalo gourd; JS 10462; LS 3752

Ibervillea lindheimeri (A. Gray) Greene; Lindheimer globeberry; JS 18078

Cuscutaceae

Cuscuta sp.; dodder; JS 18079; LH 6256

Ebenaceae

Diospyros texana Scheele; Texas persimmon; JS 18080; KW *s.n*; LS 4201

Ericaceae

Arbutus xalapensis Kunth; madrone; KW s.n.

Euphorbiaceae

Acalypha ostryifolia Riddell; hop-hornbeam copperleaf; LS 3770

Acalypha phleoides Cav.; Lindheimer copperleaf; JS 10625; FG 8214; LS 3788

Acalypha radians Torr.; round copperleaf; JS 10060

Argythamnia humilis (Engelm. & A. Gray) Muell. Arg. var. *humilis*; low wild mercury; KW s.n.; LS 3750

Argythamnia simulans J.W. Ingram; Plateau wild mercury; JS 10614; LH 4973

Bernardia myricifolia (Scheele) S. Wats.; brush myrtlecroton; JS 18081

Chamaesyce angusta (Engelm.) Small; blackfoot euphorbia; JS 10662; KW s.n.; LS 3809; 4093

Chamaesyce fendleri (Torr. & A. Gray) Small; spurge; JS 10395

Chamaesyce glyptosperma (Engelm.) Small; ridgeseed euphorbia; JS 10619

Chamaesyce maculata (L.) Small; spotted spurge; JS 10037; 10653

Chamaesyce missurica (Raf.) Shinners; spurge; JS 9963*b*

Chamaesyce nutans (Lag.) Small; eyebane; JS 9976; LS 3772; 4089

Chamaesyce prostrata (Aiton) Small; prostrate euphorbia; JS 9978; LS 4070; 4535; 4563; LH 5309

Chamaesyce serpens (Kunth) Small; mat spurge; JS 10761; KW s.n.; LS 3771; 4045

Chamaesyce serpyllifolia (Pers.) Small; thymeleaf euphorbia; JS 10653

Chamaesyce villifera (Scheele) Small; hairy euphorbia; JS 10661; LS 3949; 4064

Croton capitatus Michx.; woolly croton; JS 10016

Croton fruticulosus Engelm. ex Torr.; bush croton; JS 10660; LS 3840

Croton lindheimerianus Scheele; three-seed croton; JS 10017

Croton monanthogynus Michx.; one-seed croton; JS 10052; FG 8293; LS 3937

Croton texensis (Klotzsch) Muell. Arg.; Texas croton; JS 10047; 10660; LS 4067

Euphorbia cyathophora Murray; wild poinsettia; KW s.n.; LS 4063

Euphorbia dentata Michx.; toothed spurge; JS 10609; LH 4978

Euphorbia marginata Pursh; snow-on-the-mountain; JS 10025; LS 4102

Euphorbia roemeriana Scheele; Roemer euphorbia; JS 8477; LS 3791

Euphorbia spathulata Lam.; warty euphorbia; KW s.n.; LH 4775

Leptopus phyllanthoides (Nutt.) G.L. Webster; maidenbush; JS 10570

Phyllanthus abnormis Baill. var. *abnormis*; Drummond's leaf flower; JS 10419

Phyllanthus polygonoides Nutt. ex Spreng.; knotweed leaf flower; JS & TD 10746; FG 8250; LS 3758

Stillingia texana I.M. Johnst.; Texas stillingia; JS 10036; 10467; 10564; LS 3805

Tragia amblyodonta (Muell. Arg.) Pax. & K. Hoffm.; dogtooth noseburn; JS 10659

Tragia bentonicifolia Nutt.; betony noseburn; JS 10376

Tragia nigricans Bush; dark noseburn; JS 10382

Tragia ramosa Torr.; catnip noseburn; JS 10634; FG 8254; LS 3795

Fabaceae

Acacia greggii A. Gray; catclaw acacia; KW s.n.

Acacia roemeriana Scheele; roundflower catclaw; JS 18082; LH 4784

Amorpha fruticosa L.; indigo bush amorpha; JS 18083

Astragalus distortus Torr. & A. Gray var. *engelmannii* (Sheldon) M.E. Jones; bent pod milk vetch; JS & TD 10742

Astragalus nuttallianus DC.; small-flowered milk vetch; JS & TD 10748; KW s.n.; LH 4761

Astragalus plattensis Nutt.; Platte River milk vetch; JS 10432

Astragalus wrightii A. Gray; Wright's milk vetch; LH 4764

Cercis canadensis L. var. *texensis* (S. Wats.) M. Hopk.; Texas redbud; JS 8763; JS & TD 10734; KW s.n.; LS 3804; 4195

Dalea aurea Nutt. ex Pursh; golden dalea; JS 10571; LS 3922

Dalea frutescens A. Gray; black dalea; KW s.n.

Dalea lasiathera A. Gray; purple prairie clover; JS 18084; LS 4078

Dalea nana Torr. & A. Gray; dwarf dalea; JS 10645; LS 4542

Desmanthus acuminatus Benth.; sharp-pod bundleflower; LS 3903

Desmanthus velutinus Scheele; velvet bundleflower; JS 10650; KW s.n.; FG 8251; LS 3904

Desmodium paniculatum (L.) DC; panicled tickclover; JS 10657; LH 5314

Desmodium sessilifolium (Torr.) Torr. & A. Gray; sessileleaf tickclover; JS 10628; KW s.n.

Eysenhardtia texana Scheele; Texas kidneywood; JS 10027; 10620; KW s.n.; LS 3852

Galactia texana (Scheele) A. Gray; Texas milkpea; JS 10040; 10657

Indigofera miniata Ortega; scarlet pea; JS 18085

Lathyrus pusillus Ell.; low peavine; LH 4780

Lespedeza texana Britt.; Texas bush clover; LS 3926

Lespedeza virginica (L.) Britt.; slender lespedeza; JS 10429

Leucaena retusa Benth. in A. Gray; little-leaf leadtree; JS 10049; DH s.n.; LS 3925

Lotus unifoliolatus (Hook.) Benth. var. *helleri* (Britton) Kartesz & Gandhi; Heller's bird's-foot trefoil; JS 10410

Lupinus texensis Hook.; Texas bluebonnet; JS & TD 10737; LS 3792

**Medicago lupulina* L.; black medic; LS 3734

**Medicago minima* (L.) Bartalina; small medicago; JS & TD 10747; LS 3725

**Melilotus officinalis* (L.) Lam.; yellow sweetclover; JS 10605; 10623

Mimosa aculeaticarpa Ortega var. *biuncifera* (Benth.) Barneby; wait a bit; JS 10046

Mimosa borealis A. Gray; fragrant mimosa; JS 10222; LH 4782

Mimosa nuttallii (DC. ex Britton & Rose) B.L. Turner; catclaw sensitive brier; JS 18086

Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *scaposum* (A. Gray) Mahler; subterranean Indian breadroot; LH 4783

Prosopsis glandulosa Torr.; mesquite; JS 10472; KW s.n.; LS 3919

Rhynchosia senna Gillies ex Hook. var. *texana* (Torr. & A. Gray) M.C. Johnst.; Texas snoutbean; JS 18087; KW s.n.; LS 3781

Senna roemeriana (Scheele) Irwin & Barneby; two-leaf senna; JS 10028; 10381; FG 8291; LS 3754

Styphnolobium affine (Torr. & A. Gray) Walp.; Eve's necklacepod; JS 18088; KW s.n.; LS 4043

Vicia carolinianum Walt.; Carolina vetch; JS 10430

Vicia ludoviciana Nutt.; deer pea vetch; JS & TD 10749; KW s.n.; LS 4211

Fagaceae

Quercus buckleyi Nixon & Dorr; Buckley oak; JS 9956; KW s.n.; LS 4194

Quercus fusiformis Small; Plateau live oak; JS & TD 10714; KW s.n.; LS 4202

Quercus laceyi Small; Lacey oak; JS 10631; DH s.n.; KW s.n.; LS 4111

Quercus marilandica Muenchh.; blackjack oak; JS 10671; KW s.n.; LS 4044; 4197

Quercus muehlenbergii Engelm.; chinquapin oak; JS 10039; KW s.n.; LS 4222

Quercus pungens Liebm. var. *vaseyana* (Buckley) C.H. Mull.; Vasey shin oak; JS 9992

Quercus sinuata Walter var. *breviloba* (Torr.) C.H. Mull.; bastard oak; JS 9957; 10618; JS & TD 10713; KW s.n.; LS 4199

Quercus stellata Wang. var. *stellata*.; post oak; JS 10670; KW s.n.; LS 4196

Fumariaceae

Corydalis curvisiliqua Engelm. ssp. *curvisiliqua*; scrambled eggs; LH 4765

Corydalis micrantha (Engelm.) A. Gray; scrambled eggs; JS & TD 10687; KW s.n.

Garryaceae

Garrya ovata Benth. ssp. *lindheimeri* (Torr.) Dahling; silktassel; JS 8765; KW s.n.

Gentianaceae

Centaurium beyrichii (Torr. & A. Gray) B.L. Rob.; mountain pink; JS 10393; 10026*a*; 10632; FG 8259; LS 4415

Centaurium calycosum (Buckley) Fernald; Buckley centaury; JS 10581; LH 5022

Eustoma exaltatum (L.) Salisb. ex G. Don ssp. *russellianum* (Hook.) Kartesz; showy prairie gentian; JS 18132; LS 4413

Geraniaceae

**Erodium cicutarium* (L.) L'Her. ex Aiton; alfilaria; JS & TD 10705; KW s.n.; LS 3733

Erodium texanum A. Gray; Texas filaree; JS & TD 10704; JS 10453; LH 5861

Geranium carolinianum L.; Carolina geranium; JS 10457

Geranium texanum (Trel.) A. Heller; Texas geranium; LS 4209

Hippocastanaceae

Aesculus pavia (Sarg.) Correll var. *pavia*; red buckeye; JS & TD 10717

Hydrophyllaceae

Nama jamaicense L.; Jamaican weed; JS 10659; LH 4757

Nemophila phacelioides Nutt.; large-flower nemophila; JS & TD 10694

Phacelia congesta Hook.; spike phacelia; JS 10552; KW s.n.; LH 4975

Juglandaceae

Carya illinoinensis (Wang.) Koch; pecan; JS 9988; KW s.n.; LS 4224

Juglans major (Torr.) A. Heller; Arizona walnut; LS 4087

Juglans microcarpa Berland.; little walnut; JS 9962; 10612; DH s.n.; LS 3830

Juglans nigra L.; black walnut; JS 10562; KW s.n.

Krameriaceae

Krameria lanceolata Torr.; trailing krameria; JS 18089

Lamiaceae

Hedeoma acinoides Scheele; slender hedeoma; JS 10399; LH 4766

Hedeoma drummondii Benth.; Drummond hedeoma; JS 10396; FG 8254; LS 4046

Hedeoma nana (Torr.) Briq.; low hedeoma; JS 9977

Hedeoma reverchonii (A. Gray) A. Gray var. *reverchonii*; rock hedeoma; JS 10565; 10575

Hedeoma reverchonii (A. Gray) A. Gray var. *serpyllifolia* (Small) Irving; thymeleaf hedeoma; LS 3808; 3917

**Lamium amplexicaule* L.; henbit; JS & TD 10685; LH 5579

**Marrubium vulgare* L.; common horehound; JS 10560; FG 8271; LS 3740

**Mentha spicata* L.; spearmint; JS 10018

Monarda citriodora Cerv. ex Lag.; lemon beebalm; FG 8276; LS 4417

Monarda punctata L. ssp. *punctata* var. intermedia (E.M. McClint. & Epling) Waterf.; spotted beebalm; JS 10434

**Nepeta cataria* L.; catnip; JS 10629

Physostegia angustifolia Fernald; Edward's lionsheart; JS 10569; 10663; LS 4412; LH 4983

Salvia farinacea Benth.; mealy cup sage; JS 10383; FG 8257; LS 3739

Salvia reflexa Hornem.; lanceleaf sage; FG 8215

Salvia roemeriana Scheele; cedar sage; JS 8480; LS 3867

Scutellaria drummondii Benth.; Drummond skullcap; JS 10401; JS & TD 10710; KW s.n.; LS 3782

Scutellaria ovata Hill. ssp. *ovata*; eggleaf skullcap; JS 10035

Stachys crenata Raf.; shade betony; LH 5862

Teucrium canadense L. var. *canadense*; American germander; JS 10597; LS 3930

Trichostema brachiatum L.; flux weed; JS 18090; LS 4074; 4080; LH 6254

Warnockia scutellarioides (Engelm. & A. Gray) M.W. Turner; prairie brazoria; JS 10426; KW s.n.; LH 4990

Lauraceae

Lindera benzoin (L.) Blume; spicebush; JS 10583

Lentibularaceae

Utricularia gibba L.; cone-spur bladderwort; JS 10001

Linaceae

Linum berlandieri Hook. var. *berlandieri*; flax; JS 9982

Linum rupestre (A. Gray) Engelm. ex A. Gray; rock flax; JS 10377; LS 4059

Loasaceae

Eucnide bartonioides Zucc.; yellow rocknettle; JS 8768; 10554; LH 5555

Mentzelia oligosperma Nutt. ex Sims.; chicken-thief; JS 10452; LS 4408

Mentzelia reverchonii (Urb. & Gilg) H.J. Thomp. & Zavort.; mentzelia; JS 10572

Loganiaceae

Buddleja racemosa Torr. ssp. *incana* (Torr.) Norman; wand butterfly-bush; JS 8474

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray; lax hornpod; JS 18091; LS 4099

Lythraceae

Ammannia coccinea Rottb.; Valley redstem; JS 18092

Lythrum ovalifolium Koechn.; low loosestrife; JS 10063

Malpighiaceae

Galphimia angustifolia Benth.; narrowleaf thryallis; JS 18093; FG 8211; LS 3860

Malvaceae

Abutilon fruticosum Guill. & Perrottet; Texas Indian mallow; JS 10658; FG 8256*a*; LS 3799; 4538

Callirhoe pedata (Nutt. ex Hook.) A. Gray; finger poppy mallow; JS 10438

Rhynchosida physocalyx (A. Gray) Fryxell; buff petal; LS 3776

Sida abutifolia Mill.; spreading sida; JS 10038; 10647; 10800; FG 8247; LS 3789

Sida lindheimeri Engelm. & A. Gray; showy sida; JS 10061; 10658

Sphaeralcea angustifolia (Cav.) G. Don. var. *angustifolia*; leaf globe mallow; KW s.n.

Meliaceae

**Melia azedarach* L.; chinaberry; KW s.n.; LH 4786

Menispermaceae

Cocculus carolinus (L.) DC.; Carolina snailseed vine; JS 8491; 10012; KW s.n.; LS 3953

Molluginaceae

Glinus radiatus (Ruiz & Pavon) Rohrb.; spreading sweetjuice; JS 18094

Mollugo verticillata L.; green carpetweed; JS 18095

Moraceae

Morus microphylla Buckley; Texas mulberry; JS 9990; 10551; KW s.n.; LS 4219

Morus rubra L.; red mulberry; JS 10593

Nyctaginaceae

Boerhavia diffusa L.; scarlet spiderling; JS 18096

Mirabilis albida (Walt.) Heimerl; four-o'clock; KW s.n.; LS 3796; 4066; 4545; 4559

Mirabilis nyctaginea (Michx.) MacMill; heartleaf four-o'clock; JS 10557

**Mirabilis jalapa* L.; marvel of Peru; LS 4530

Mirabilis linearis (Pursh.) Heimerl; linearleaf four-o'clock; JS 10373; JS & TD 10731; LH 6258

Oleaceae

Forestiera pubescens Nutt.; elbowbush; JS 8766; 10636; KW s.n.; LS 4200

Forestiera reticulata Torr.; netleaf foresteria; JS 18097

Fraxinus texensis (A. Gray) Sarg.; Texas ash; JS 18098

Menodora longiflora A. Gray; showy menodora; LS 4054

Onagraceae

Calylophus berlandieri Spach ssp. *berlandieri*; halfshrub sundrops; JS 18099

Ludwigia peploides (Kunth. in H.B. K.) P.H. Raven; floating primrose-willow; JS 18100

Ludwigia repens J.R. Forst.; roundleaf seedbox; JS 18101

Oenothera grandis (Britt.) Smyth; grand evening primrose; JS 10435

Oenothera speciosa Nutt.; showy primrose; KW s.n.

Oenothera triloba Nutt.; stemless evening primrose; KW s.n.; LH 4787

Stenosiphon linifolius (Nutt. ex James) Heynh.; false gaura; JS 18102

Oxalidaceae

Oxalis dillenii Jacq.; Dillen's oxalis; JS 18133; FG 8314

Oxalis drummondii A. Gray; purple wood sorrel; LS 4083

Oxalis stricta L.; yellow wood sorrel; KW s.n.; LS 3775

Papaveraceae

Argemone albiflora Hornem. ssp. *texana* G.B. Ownbey; white prickle poppy; JS 18103

Argemone aurantiaca G.B. Ownbey; Texas prickle poppy; LS 3786

Passifloraceae

Passiflora affinis Engelm.; bracted passionflower; JS 9987

Passiflora lutea L.; yellow passionflower; JS 10555; KW s.n.

Passiflora tenuiloba Engelm.; spread-lobe passionflower; JS 10009; LS 4094

Pedaliaceae

Proboscidea louisianica (Mill.) Thell. ssp. *louisianica*; common devil's claw; JS 10018

Phytolaccaceae

Phytolacca americana L.; pokeweed; JS 8502; LH 5322

Rivina humilis L.; rougeplant; JS 18104

Plantaginaceae

Plantago helleri Small; cedar plantain; LS 3761

Plantago patagonica Jacq.; bristle bract plantain; JS & TD 10750; KW s.n.

Plantago rhodosperma Decne.; redseed plantain; JS 10413; JS & TD 10751; LH 4980

Plantago virginica L.; paleseed plantain; JS 10402

Platanaceae

Platanus occidentalis L.; sycamore; JS 18105; KW s.n.; LS 3829

Polemoniaceae

Giliastrum rigidulum (Benth.) Rydb.; prickleaf gilia; JS & TD 10738; LS 3938

Phlox drummondii Hook.; Drummond phlox; JS 10439

Phlox roemeriana Scheele; Roemer phlox; JS & TD 10736; LH 4768

Polygalaceae

Polygala alba Nutt.; white milkwort; JS 18106

Polygala lindheimeri A. Gray; shrubby milkwort; JS 18107; LH 6053

Polygonaceae

Polygonum hydropiperoides Michx.; swamp smartweed; JS 18109

Polygonum lapathifolium L.; curltop smartweed; JS 18110

**Rumex crispus* L.; curly dock; JS 18111

**Rumex pulcher* L.; fiddle dock; LS 3743

Portulacaceae

**Portulaca oleracea* L.; common purslane; KW s.n.; JS 18112

Portulaca pilosa L.; shaggy purslane; JS 18113; KW s.n.; LS 3954

Phemeranthus aurantiacus (Engelm.) Kiger; orange fameflower; KW s.n.; FG 8258

Primulaceae

Samolus ebracteatus Kunth.; limerock brookweed; JS 8478; 10024; LS 3853

Samolus valerandi L. ssp. *parviflorus* (Raf.) Hulten; thin-leaf brookweed; LS 3837; 3866

Ranunculaceae

Anemone berlandieri Pritz.; tenpetal anemone; JS & TD 10686

Anemone caroliniana Walt.; Carolina anemone; JS & TD 10689; KW s.n.

Aquilegia canadensis L.; American columbine; JS 10587

Clematis drummondii Torr. & A. Gray; Texas virginsbower; JS & TD 10697; KW s.n.; LS 4069

Clematis pitcheri Torr. & A. Gray; purple leather flower; JS 10559; 10823; LS 3861

Clematis texensis Buckley; scarlet clematis; JS 18114

Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks; Carolina larkspur; JS 10440; KW s.n.

Rhamnaceae

Berchemia scandens (Hill) K. Koch; Alabama supplejack; JS 18115

Ceanothus herbaceus Raf.; redroot; JS 10567

Colubrina texensis (Torr. & A. Gray) A. Gray; Texas colubrina; JS 10622

Condalia ericoides (A. Gray) M.C. Johnst.; javelina bush; JS 8769

Condalia hookeri M.C. Johnst.; brasil; JS 10470; KW s.n.

Condalia spathulata A. Gray; knifeleaf condalia; LS 4205

Frangula caroliniana (Walter) A. Gray; Carolina buckthorn; JS 18116; DH s.n.

Ziziphus obtusifolia (Hook. ex Torr. & A. Gray) A. Gray var. *obtusifolia*; lotebush; JS 10621

Rosaceae

Cercocarpus montanus Raf.; true mountain mohagany; JS 8497

Crataegus sp.; hawthorn; KW s.n.

Geum canadense Jacq.; white avens; JS 18117; LS 3850

Petrophytum caespitosum (Nutt.) Rydb.; rock spirea; JS 8767; LS 4121

Prunus angustifolia Marsh.; chickasaw plum; JS 10648

Prunus serotina Ehrh. var. *eximia* (Small) Little; Escarpment black cherry; JS 10020; JS & TD 10715; KW s.n.; LS 4203

Prunus texana D. Dietr.; Texas peach; JS 8481

Rubus trivialis Michx.; southern dewberry; JS 18118

Rubiaceae

Cephalanthus occidentalis L.; common button bush; JS 10637; KW s.n.; LS 3933

Galium aparine L.; catchweed bedstraw; JS & TD 10752; KW s.n.; LS 3759

Galium texense A. Gray; Texas bedstraw; JS 10409; KW s.n.; LS 3745
Galium virgatum Nutt.; southwest bedstraw; LS 4213
Houstonia pusilla Schoepf ; tiny bluet; JS 18119
**Sherardia arvensis* L.; spurwort; JS & TD 10690
Stenaria nigricans (Lam.) Terrell var. *nigricans*; fineleaf bluets; JS 8488; 10374; FG 8263; KW s.n.; LS 3807

Rutaceae

Ptelea trifoliata L.; hoptree; JS 10820
Thamnosma texana (A. Gray) Torr.; dutchman's breeches; JS 18120; LS 3810
Zanthoxylum hirsutum Buckley; pricklyash; JS 18121; KW s.n.

Salicaceae

Populus deltoides Bartram ex Marsh. ssp. *deltoides*; cottonwood; JS 18122
Salix nigra Marsh.; black willow; JS 18123; LS 4223

Sapindaceae

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson; western soapberry; JS 10011; 10591
Ungnadia speciosa Endl.; Mexican buckeye; JS & TD 10167; KW s.n.; LS 4215

Sapotaceae

Sideroxylon lanuginosum Michx. ssp. albicans (Sarg.) Kartesz & Gandhi; gum bully; JS 9993; 10633; KW s.n.; LS 3944

Scrophulariaceae

Agalinis edwardsiana Pennell; Plateau gerardia; JS 18124
Agalinis homalantha Pennell; San Antonio false foxglove; JS 18125
Bacopa monnieri (L.) Pennell; coastal water hyssop; JS 18126
Buchnera americana L.; American bluehearts; JS 9966; 10616; LS 3862
Leucospora multifida (Michx.) Nutt.; narrow leaf conobea; JS 10061, 10221, 10599, 15967; LS 3857
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperr.; clasping false pimpernel; JS 10465
Maurandella antirrhiniflora (Humb. & Bonpl. ex Willd.) Rothm.; snapdragon vine; JS 8492; LS 3827
Mecardonia procumbens (Mill.) Small; prostrate water hyssop; JS 10666; LS 3856
Nuttallanthus canadensis (L.) D.A. Sutton; Texas toadflax; JS & TD 10709; KW s.n.
Penstemon cobaea Nutt.; foxglove; JS 10550
Penstemon triflorus A. Heller ssp. *triflorus*; Heller penstemon; JS 18127
**Verbascum thapsus* L.; flannel mullein; JS 10608; FG 8256; LH 5025
**Veronica agrestis* L.; wayside purslane; JS 10607
**Veronica arvensis* L.; common speedwell; LS 3718
Veronica peregrina L.; purslane speedwell; JS & TD 10692; LS 3744

Solanaceae

Chamaesaracha coronopus (Dunal) A. Gray; green false nightshade; KW s.n.
Chamaesaracha edwardsiana Averett; Plateau flase nightshade; LS 4547
Chamaesaracha sordida (Dunal) A. Gray; hairy false nightshade; JS 10474
**Datura stramonium* L.; jimsonweed; JS 8484
Nicotiana repanda Willd. ex Lehm.; fiddle leaf tobacco; JS 8764
Nicotiana trigonophylla Dunal; desert tobacco; LS 3868
Physalis cinerascens (Dunal) Hitchc. var. cinerascens; smallflower groundcherry; JS 8503; LS 3777; 3950; 4065
Physalis mollis Nutt. var. *mollis*; field groundcherry; KW s.n.
Solanum citrullifolium A. Braun var. *citrullifolium*; melon nightshade; JS 10412
Solanum dimidiatum Raf.; western horse nettle; JS 9955
Solanum elaeagnifolium Cav.; silver leaf nightshade; JS 10051; FG 8293; LS 3736
Solanum ptycanthum Dunal; American nightshade; KW s.n.; LS 4553
Solanum rostratum Dunal; buffalo bur; JS 9954; LS 4075

Sterculiaceae

Hermannia texana A. Gray; Mexican mallow; LS 3939

Ulmaceae

Celtis laevigata Willd. var. *laevigata*; sugar hackberry; JS 18128; KW s.n.
Celtis laevigata Willd. var. *reticulata* (Torr.) L.D. Benson; netleaf hackberry; JS 9994; DH s.n.; LS 4198
Celtis laevigata Willd. var. *texana* Sarg.; Texas hackberry; LH 5625
Celtis ehrenbergiana (Klotzsch) Liebm.; spiny hackberry; JS 10041
Ulmus americana L.; American elm; JS 9989
Ulmus crassifolia Nutt.; cedar elm; JS & TD 10735; DH s.n.; KW s.n.; LS 4092
Ulmus rubra Muhl.; slippery elm; JS 10003; KW s.n.

Urticaceae

Boehmeria cylindrica (L.) Sw.; false nettle; JS 10019; LS 4103
Parietaria pensylvanica Muhl. ex Willd.; Pennsylvania pelitory; JS & TD 10691; KW s.n.; LS 3719
Urtica chamaedryoides Pursh; heart-leaf nettle; JS & TD 10699; LH 4760

Valerianaceae

Valerianella amarella (Lindh. ex Engelm.) Krok; hairy corn salad; JS 10427; KW s.n.; LH 4781
Valerianella stenocarpa (Engelm. ex A. Gray) Krok; bigflower cornsalad; JS & TD 10721; KW s.n.

Verbenaceae

Aloysia gratissima (Gillies & Hook.) Troncoso; whitebrush; JS 10002; LS 3913
Glandularia bipinnatifida (Nutt.) Nutt. var. *bipinnatifida*; Dakota vervain; FG 8255; KW s.n.; LS 3747; 4061
Glandularia pumila (Rydb.) Umber; pink vervain; JS & TD 10754; KW s.n.; LH 4756
Phyla nodiflora (L.) Greene; frogfruit; JS 18129; LS 3849
**Verbena brasiliensis* Vell.; Brazilian vervain; LS 3865; 4098
Verbena canescens Kunth; gray vervain; JS & TD 10753; FG 8260; KW s.n.; LS 3726; 3905; 3951; 3955
Verbena halei Small; slender vervain; JS 10451; LS 3915

Verbena scabra Vahl; harsh vervain; JS 9999; 15968; JS & TD 10688; LS 4097
Verbena xutha Lehm.; coarse verbena; JS 10415

Violaceae

Hybanthus verticillatus (Ortega) Baill. var. *verticillatus*; whorled nod violet; JS 10378; KW s.n.; LS 3811; LH 4767; 6054; 6055; 6056; 6057
Viola bicolor Pursh; field pansy; JS 10015

Viscaceae

Phoradendron tomentosum (DC.) Engelm. ex A. Gray; Christmas mistletoe; LS 3920

Vitaceae

Ampelopsis cordata Michx.; heartleaf ampelopsis; LS 3834; LH 5864
Cissus trifoliata (L.) L.; treebine; JS 10059
Parthenocissus heptaphylla (Buckley) Britton ex Small; seven-leaf creeper; KW s.n.; LS 3828
Parthenocissus quinquefolia (L.) Planch.; Virginia creeper; JS 9967
Vitis cinerea (Engelm.) Engelm. ex Millardet var. *helleri* (L.H. Bailey) M.O. Moore; Spanish grape; LH 4774
Vitis monticola Buckley; sweet mountian grape; JS 10548; KW s.n.; LS 3835
Vitis mustangensis Buckley; mustang grape; JS 9959
Vitis riparia Michx.; riverbank grape; JS 10056
Vitis rupestris Scheele; sand grape; KW s.n.

Zygophyllaceae

Kallstroemia parviflora J.B.S. Norton; warty caltrop; LS 4533
**Tribulus terrestris* L.; puncturevine; JS 9980; FG 8301

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ANNOUNCEMENT

THE 2010 APPLICATIONS FOR THE DELZIE DEMAREE TRAVEL AWARD

Applications for the 2010 Delzie Demaree Travel Award should include a letter from the applicant telling how symposium attendance will benefit his/her graduate work and a letter of recommendation sent by the major professor. Please send letters of application to: Dr. Donna M.E. Ware, P.O. Box 8795, Herbarium, Biology Department, The College of William and Mary, Williamsburg, VA 23185-8795, U.S.A. 1-757-221-2799; Email: ddmware@wm.edu. The period for receiving applications will end three weeks prior to the date of the symposium if a sufficient number of applications are in hand at that time. Anyone wishing to apply after that date should inquire whether applications are still being accepted before applying. The 57th Annual Systematics Symposium, Missouri Botanical Garden dates for 2010 are 15–16 October 2010.

The Delzie Demaree Travel Award was established in 1988 honoring Delzie Demaree who attended 35 out of a possible 36 symposia before he died in 1987. Delzie Demaree was a frontier botanist, explorer, discoverer, and teacher. His teaching career as a botanist began in Arkansas at Hendrix College in 1922. He also taught botany at the University of Arkansas, Navajo Indian School, Yale School of Forestry, Arkansas A&M, and Arkansas State University at Jonesboro where he retired as professor emeritus in 1953. One of the things he enjoyed most as a botanist was assisting students with their field botany research.

Anyone interested in making a contribution to Delzie Demaree Endowment Fund, which supports the travel award, may make contributions by VISA or MasterCard or by a check, payable to Botanical Research Institute of Texas, to Barney Lipscomb, 500 E 4th Street, Fort Worth, TX 76102-4025, U.S.A. 1-817-332-7432; Email: barney@brit.org. Thank you.

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ANNOTATED CHECKLIST OF THE VASCULAR PLANTS OF FORT HOOD, TEXAS

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ABSTRACT

Fort Hood Military Reservation consists of 88,742 hectares in Bell and Coryell counties, Texas. This annotated checklist documents 1,014 taxa in 896 species, 513 genera, and 120 families. There are 848 native taxa and 166 introduced. Twelve taxa have a global or state ranking. Two taxa are endemic to north central Texas, *Yucca pallida* and *Croton alabamensis* var. *texensis*, and 40 are endemic to Texas.

RESUMEN

La Fort Hood Military Reservation consiste en 88,742 hectáreas en los condados de Bell y Coryell, Texas. Este catálogo anotado documenta 1,014 taxa de 896 especies, 513 géneros, y 120 familias. Hay 848 taxa nativos y 166 introducidos. Doce taxa tienen estatus de protección global o estatal. Dos taxa son endémicos del centro-norte de Texas, *Yucca pallida* y *Croton alabamensis* var. *texensis*, y 40 son endémicos de Texas.

INTRODUCTION

Fort Hood Military Reservation, located in central Texas (Fig. 1), is 88,742 hectares. There is no agreement as to what vegetation region defines this part of Texas. Diggs et al. (1999) place it within the Lampasas Cut Plain. LBJ School of Public Affairs (1978) considers it to be in the Edwards Plateau Ecoregion. Others have placed it in the Cross Timbers and Prairies (Gould 1962; Correll & Johnston 1979; Diggs et al. 1999) and in the Blackland Prairie (Mahler 1988). The flora shows affinities to all of these ecoregions.

The Army acquired the lands of Fort Hood by eminent domain beginning in 1942. Prior to this, the lands of Fort Hood were privately held and used for livestock grazing and crop production. Fort Hood is an Army base used primarily for military training, including large-scale troop and ground vehicle maneuvers, live fire weapons and aviation training. There are over 45,000 active duty Army personnel, as well as Army National Guard personnel training on Fort Hood. The land is also managed for multiple use, including recreation, fishing, hunting, and livestock grazing.

The first known checklist of Fort Hood was compiled by CEMML (1994). It was based on an inventory of the Fort Hood Herbarium (HOOD) and additional field collections during 1992–1993. The list documented 642 taxa. However, 67 of these were deleted from the list, as follows: 29 names were synonyms, 28 were corrected to a taxa already listed, and 10 lacked vouchers and were out of range. Thus, the number of taxa was reduced to 575.

The purpose of this present study is to update the checklist and provide information on frequency of occurrence and habitat for each taxon.

SITE DESCRIPTION

Fort Hood is located in Bell and Coryell counties, from 31.0105 N to 31.3929 N and 97.4676 W to 97.9121 W. Elevation ranges from 180 m to 375 m above mean sea level. Terrain varies from riparian corridors, alluvial bottomlands, rolling grasslands, steep slopes and canyons, and flat topped mesas. The underlying geology is Edwards Limestone, Comanche Peak Limestone, Walnut Clay, Paluxy Sand, and Glen Rose Limestone. Soils are classified as clay loam, silty clay, sandy loam, and limestone rock outcrop (NRCS 2009b).

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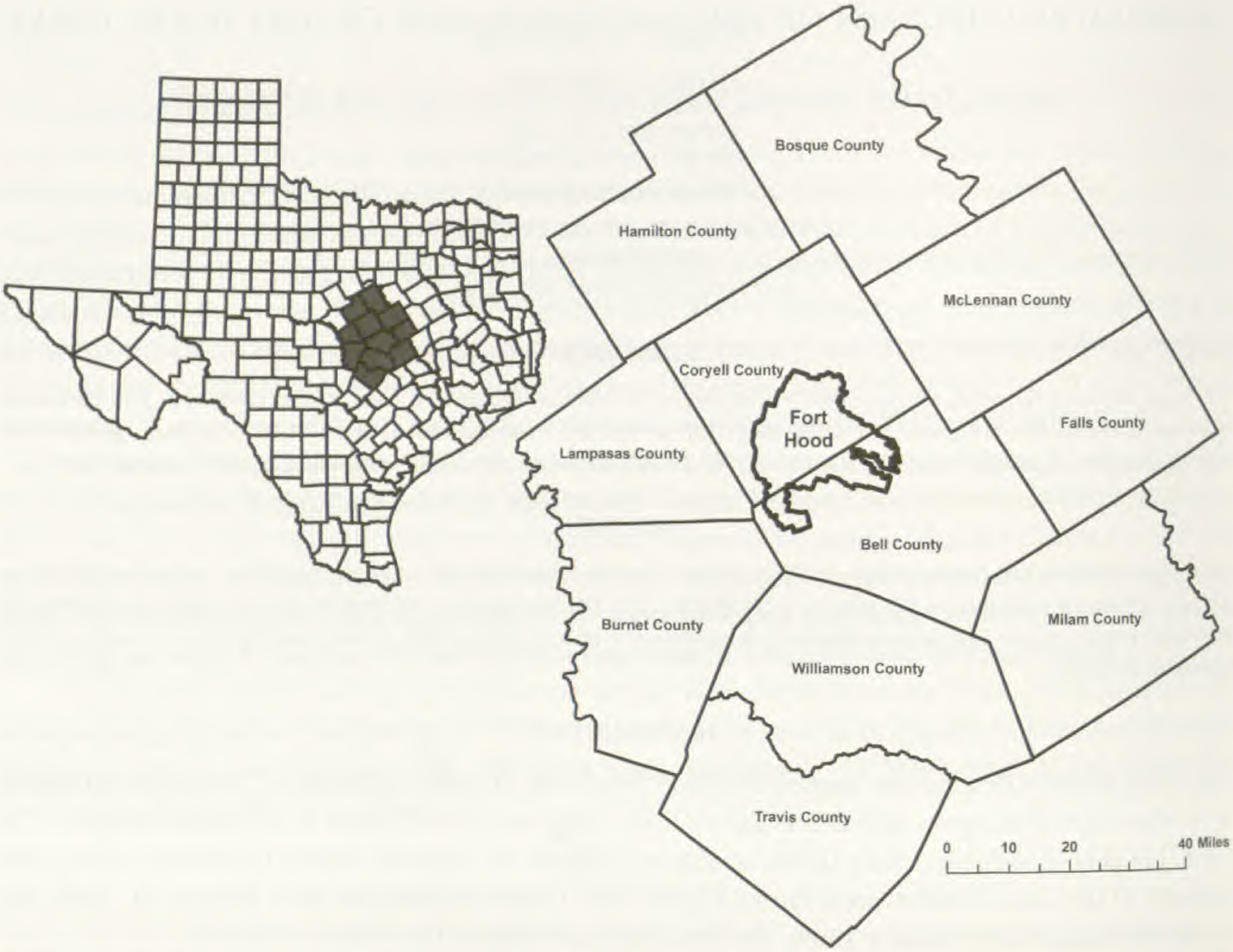

Fig. 1. Location of Fort Hood Military Reservation in Texas with surrounding counties.

The climate is characterized by long, hot summers and mild winters. Mean high temperature for July is 35°C, with a low of 23°C. January mean high and low are 15°C and 5°C, respectively. Annual precipitation averages 69 cm, with most rain falling in the spring and fall (Weatherbase 2009).

Historic vegetation likely consisted of tall- or mixed-grass prairies, oak savannas, oak shrublands, oak-juniper woodlands, riparian forests, and floodplain forests (Bray 1904; Palmer 1920; Tharp 1939; Gehlbach 1988; Van Auken et al. 1979, 1980, 1981). Fire plays a role in these communities and many native plants are fire adapted (Bray 1904; Smeins 1980; Reemts & Hansen 2008).

Current vegetation is classified as forest (8%), woodland (40%), shrubland (6%), grassland (34%), and not vegetated/developed (12%), with 35 associations described and 70 classes (Teague & Reemts 2007). Major forest communities include *Quercus buckleyi-Fraxinus texensis-Juniperus ashei* Forest and *Acer grandidentatum-(Quercus muehlenbergii)/Carex edwardsiana* Lampasas Cutplain Forest. Woodlands are primarily *Quercus fusiformis-Quercus buckleyi-Ulmus crassifolia/Schizachyrium scoparium* Woodland and *Quercus stellata-(Quercus marilandica, Ulmus crassifolia)/Schizachyrium scoparium* Woodland, *Juniperus ashei-Quercus sinuata* var. *breviloba* Woodland, and *Prosopis glandulosa/Bouteloua curtipendula-Nassella leucotricha* Woodland. Shrublands are dominated by *Quercus sinuata* var. *breviloba* Shrubland. Grassland areas include disturbed herbaceous vegetation and *Schizachyrium scoparium-Bouteloua curtipendula-Nassella leucotricha* Herbaceous Vegetation (Teague & Reemts 2007).

No federally listed plant species are known to occur on Fort Hood. However, three federally listed birds are known on Fort Hood. These include, the golden-cheeked warbler (*Dendroica chrysoparia*), the black-capped vireo (*Vireo atricapillus*), and the bald eagle (*Haliaeetus leucocephalus*). Golden-cheeked warbler is a neotropical migrant songbird that nests only in central Texas. Its preferred habitat consists of old-growth mixed woodlands, where Ashe juniper is mature enough to have shredding bark (Pulich 1976; Kroll 1980; Ladd & Gass 1999; Dearborn & Sanchez 2001; Baccus et al. 2007). Black-capped vireo is also a neotropical migrant songbird. Its preferred habitat consists of low, scrubby clumps of mainly deciduous species, with low Ashe juniper cover and open spaces in between clumps (Graber 1961; Grzybowski et al. 1994; Grzybowski 1995). Bald eagle is a winter resident on the eastern side of the installation, along the shores of Belton Lake.

METHODS

Additional field collecting was conducted from 1995 to 2010. Voucher specimens were collected according to standard collecting methods. Material was keyed with appropriate floras (Bailey 1949; Stanford 1976; Correll & Johnston 1979; Diggs et al. 1999; FNA 1993+) and compared to specimens at BAYLU, HOOD, TEX, and LL. Specimens were deposited at HOOD, with some specimens and duplicates located at BAYLU, CMML, HABAYC, HPC, LL, MO, SWT, TAES, and TEX. Herbarium searches yielding additional taxa were conducted at HABAYC, HPC, LL, and TEX. Nomenclature follows NRCS (2009a), with the following exceptions: *Buchnera floridana*, *Centaurium muehlenbergii*, and *Phlox villosissima* follow Turner et al. (2003) and *Mirabilis latifolia* follows FNA (1993+). Native is defined as native to Texas, and introduced is defined as introduced to Texas (as list in Nesom 2009).

The checklist includes all native and introduced taxa known to occur on the lands of Fort Hood. Many ornamental species, planted by the previous land owners, have naturalized or persisted, and are thus included in this checklist. However, plantings of ornamental species in the garrison areas are not included.

RESULTS

This study documents an additional 439 taxa to the checklist of Fort Hood, bringing the total to 1,014 taxa (species and below) in 896 species, 513 genera, and 120 families. This represents 43% of the 2,376 taxa recorded for north central Texas (Diggs et al. 1999). There are 3,793 voucher specimens in the Fort Hood Herbarium (HOOD). Seven hundred ninety-eight are presumed new county records, with 245 records from Bell County and 553 from Coryell County.

Families with the greatest number of taxa are the Poaceae (151), Asteraceae (133), Fabaceae (80), Cyperaceae (42), Euphorbiaceae (37), and Lamiaceae (26). These six families comprise 46.3% of the flora. Other large families include Apiaceae (23), Brassicaceae (21), Onagraceae (20), Rosaceae (20), Scrophulariaceae (20), and Apocynaceae (19). Genera with the greatest number of taxa are *Carex* (13), *Cyperus* (12), *Dichanthelium* (11), *Eragrostis* (11), *Juncus* (10), *Chamaesyce* (9), *Dalea* (8), *Quercus* (8), *Panicum* (8), *Allium* (7), *Croton* (7), *Euphorbia* (7), *Gaura* (7), and *Paspalum* (7).

There are 166 taxa introduced to Texas in 165 species (Nesom 2009) recorded, comprising 16.4% of the flora of Fort Hood. Twelve taxa (Table 1) have a global or state ranking (Carr 2005; Poole et al. 2007), representing 1.2% of the flora. *Opuntia engelmannii* var. *linguiformis*, which is ranked G5T1QS1, is not included in Table 1, because I am certain it was planted, as it is only found at a few old homesites. Two taxa are endemic to north central Texas (Diggs et al. 1999), *Yucca pallida* and *Croton alabamensis* var. *texensis*. Taxa that are endemic to the state and restricted to the Edwards Plateau (Carr 2007) include *Argythamnia simulans*, *Astragalus wrightii*, *Carex edwardsiana*, *Chaetopappa bellidifolia*, *Monarda punctata* ssp. *punctata* var. *intermedia*, *Muhlenbergia involuta*, *Parthenocissus heptaphylla*, *Passiflora affinis*, *Prunus serotina* var. *eximia*, *Styrax platanifolius* ssp. *platanifolius*, *Vitis monticola*, and *Yucca rupicola*.

The following taxa are endemic to Texas but not restricted to the Edwards Plateau Ecoregion (Carr 2007): *Amphiachyris amoena*, *Arabis petiolaris*, *Argemone aurantiaca*, *Astragalus reflexus*, *Castilleja purpurea* var. *lindheimeri*, *Clematis texensis*, *Cryptantha texana*, *Dalea hallii*, *Dalea tenuis*, *Daucosma laciniata*, *Dichondra recurvata*, *Lechea san-sabeana*, *Lesquerella recurvata*, *Malvastrum aurantiacum*, *Matelea edwardsensis*, *Nolina lindheimeriana*, *Pectis angustifolia* var. *fastigiata*, *Pediomelum cyphocalyx*, *P. hypogaeum* var. *scaposum*, *P. latestipulatum* var. *appressum*, *Phlox roemeriana*, *Ruellia drummondiana*, *Salvia engelmannii*, *Silphium albiflorum*, *Tradescantia edwardsiana*, *T. humilis*, *Tridens congestus*, and *Verbesina lindheimeri*.

Table 1. Ranked taxa documented in the flora of Fort Hood, Texas.

Species	Rank
Matelea edwardsensis	G3G4S3S4
Cucurbita pepo var. *texana*	G3S3
Cuscuta exaltata	G3S3
Croton alabamensis var. *texensis*	G3T2S2
Astragalus reflexus	G3S3
Dalea hallii	G3S3
Pediomelum cyphocalyx	G3G4S3S4
Clematis texensis	G3G4S3S4
Agalinis densiflora	G3S2
Styrax platanifolius ssp. *platanifolius*	G3T3S3
Hexalectris nitida	G3S3
Festuca versuta	G3S2S3

The following are comments on unusual or interesting plant distributions. *Isoetes butleri* has few reports from Texas. *Cyperus eragrostis* is known in Texas only from Harris County. *Cynanchum barbigerum* is at the northern limit of its distribution.

The following taxa are at the western limit of their distribution: *Acmella oppositifolia* var. *repens*, *Andropogon virginicus*, *Botrychium virginianum*, *Carex corrugata*, *Carex lurida*, *Claytonia virginica*, *Commelina diffusa*, *Cyperus erythrorhizos*, *Cyperus pseudovegetus*, *Dichanthelium depauperatum*, *Dichanthelium malacophyllum*, *Diodia virginiana*, *Elephantopus carolinianus*, *Eragrostis hirsuta*, *Erechtites hieraciifolia*, *Eryngium hookeri*, *Euonymus atropurpurea* var. *atropurpurea*, *Gaura longiflora*, *Helianthemum rosmarinifolium*, *Ilex vomitoria*, *Juncus dichotomus*, *Juncus effusus* var. *solutus*, *Juniperus virginiana*, *Leersia virginica*, *Lespedeza procumbens*, *Lespedeza repens*, *Paspalum floridanum*, *Phryma leptostachya*, *Pleopeltis polypodioides* ssp. *michauxiana*, *Polygala incarnata*, *Ranunculus fascicularis*, *Scirpus pendulus*, *Scleria ciliata*, *Scleria oligantha*, *Senna marilandica*, *Stylosanthes biflora*, *Thelypteris kunthii*, *Trepocarpus aethusae*, *Tridens congestus*, *Viola bicolor*, *Vitis vulpina*, and *Zanthoxylum clava-herculis*.

The following taxa are at the eastern limit of their distribution: *Ammoselinum popei*, *Asclepias engelmanniana*, *Astrolepis integerrima*, *Chamaesaracha coniodes*, *Dalea nana* var. *nana*, *Juniperus pinchotii*, *Maurandella antirrhiniflora*, and *Wedelia texana*.

DISCUSSION

When compared to other floristic studies within the Edwards Plateau, Fort Hood has a higher number of taxa. For example, 583 taxa were found in central and western Bell County (Beaty 1978), 693 taxa at Mason Mountain Wildlife Management Area, Mason County (Singhurst et al. 2007), 728 taxa at Balcones Canyonlands National Wildlife Refuge, Burnet, Travis, and Williamson counties (BCNWR 2008), and 725 taxa at Kerr Wildlife Management Area, Kerr County (Singhurst et al. 2010). This high number of taxa occurring on Fort Hood is likely a result of its large size, its location at the intersection of three ecoregions, the large number of plant communities, and the inclusion of persisting cultivated species.

The number of taxa documented at Fort Hood is compatible to other large-sized military installations. Fort Benning (2005) reported 1,350 taxa at Fort Benning, Georgia (73,650 ha), Anderson (2007) reported 1,132 taxa at White Sands Missile Range, New Mexico (830,000 ha), Fort Bliss (2001) reported 1,200 taxa at Fort Bliss, Texas and New Mexico (453,250 ha), and Sorrie et al. (2006) reported 1,185 taxa at Fort Bragg, North Carolina (60,140 ha).

Texas endemics comprise 4.1% of the flora. This is similar to the 4.0% reported for the flora of north central Texas (Diggs et al. 1999), but lower than 5.9% reported for Travis County (Carr 2004). There is a high percentage of introduced taxa (16.3%), but lower than 17.7% reported for north central Texas (Diggs et al. 1999). This compares favorably with Fort Bragg, North Carolina, which has 16.8% introduced taxa (Sorrie et al. 2006). However, other military bases had much lower numbers of introduced taxa. White Sands Missile Range, New Mexico has 11.4% introduced (Anderson 2007) and Fort Benning, Georgia has 4.4% (Fort Benning 2005).

ANNOTATED CHECKLIST OF VASCULAR PLANT TAXA

Taxa are arranged by divisions, with flowering plants subdivided into classes. Within these groups, taxa are listed alphabetically by family, genus, species, and infraspecific rank. Taxa that are endemic to Texas are listed in **bold** font. Common names follow NRCS (2009a). Taxa are defined as native to Texas or introduced, and duration is given. Frequency of occurrence is given as: rare, very difficult to find and limited to one or a few locations; occasional, difficult to find but found in several locations; frequent, widely scattered and not difficult to find; and common, easily found in most habitats. Brief habitat descriptions are given and the most recently collected specimen is listed for each county with collector and number. Specimens representing presumed new county records are listed in **bold** font. Specimens are located at the Fort Hood Herbarium (HOOD) unless otherwise noted.

The following abbreviations are used for collectors: **BH** = Bryan Hummel; **BRJ** = B.R. Jones; **BT** = Billie L. Turner; **CC** = Chuck Coffey; **CLGY** = C.L. & G. York; **CLY** = C.L. York; **CR** = Charlotte Reemts; **GG** = Greg Gust; **JC** = John Cornelius; **JJ** = Joye Johnson; **JS** = John Stone; **JW** = J.K. Wipff; **KSNH** = K. Schulz & N. Hastings; **KSRS** = K.A. Schulz & R.M. Smith; **LH** = Laura Hansen (**LS** = Laura Sanchez); **RKGL** = R. Krohn & G. Liburn; **RTBS** = Ross T. Bowlin Sherwood; **SEW** = Simon E. Wolff; **SKJ** = Sheila K. Jackson; **SJC** = Sgt. J. Cohn; **SMKL** = Schulz, Morrison, Krohn, & Liburn; **VM** = V. Morrill; and **WRC** = W.R. (Bill) Carr.

LYCOPODIOPHYTA

Isoetaceae

Isoetes butleri Engelm., limestone quillwort. Native, perennial. Rare in seasonally seeping limestone soil. Bell Co.: **LH 4916**, Coryell Co.: **CR 68**

EQUISETOPHYTA

Equisetaceae

Equisetum hyemale L. var. *affine* (Engelm.) A.A. Eat., scouringrush horsetail. Native, perennial. Rare in moist soil along rivers and creeks. Bell Co.: **LS 760**, Coryell Co.: **LH 6031**

PTERIDOPHYTA

Aspleniaceae

Asplenium resiliens Kunze, black-stem spleenwort. Native, perennial. Frequent on limestone in mesic wooded canyons. Bell Co.: LS 4597, Coryell Co.: LS 2634

Dryopteridaceae

Cyrtomium falcatum (L. f.) C. Presl, Japanese net-vein holly fern. Introduced, perennial. Occasional on mesic limestone cliffs and sinkhole openings, naturalized. Bell Co.: **LS 4651**, Coryell Co.: **LS 2648**

Woodsia obtusa (Spreng.) Torr. ssp. *occidentalis* Windham, western cliff fern. Native, perennial. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LS 3383**

Marsileaceae

Marsilea vestita Hook. & Grev., hairy waterclover. Native, perennial. Frequent in seasonally damp soil. Bell Co.: LH 5177, Coryell Co.: LH 5163

Ophioglossaceae

Botrychium virginianum (L.) Sw., rattlesnake fern. Native, perennial. Rare in mesic wooded canyons. Bell Co.: LS 4245, Coryell Co.: **LH 5851**

Polypodiaceae

Pleopeltis polypodioides (L.) Andrews & Windham ssp. *michauxiana* (Weatherby) Andrews & Windham, resurrection fern. Native, perennial. Rare on limestone boulders in mesic wooded canyon. Bell Co.: **LS 2106**

Pteridaceae

Adiantum capillus-veneris L., common maidenhair. Native, perennial. Frequent on seeping limestone in riparian areas and mesic wooded canyons. Bell Co.: LS 1974, Coryell Co.: **LS 3968**

Argyrochosma dealbata (Pursh) Windham, powdery false cloak fern. Native, perennial. Occasional on dry limestone rimrock at upper edges of wooded canyons and slopes. Bell Co.: LS 3979, Coryell Co.: **LH 5066**

Astrolepis integerrima (Hook.) Bentham & Windham, hybrid cloak fern. Native, perennial. Rare on limestone in mesic wooded canyons. Bell Co.: **LH 5400**, Coryell Co.: **LH 5259**

Cheilanthes alabamensis (Buckley) Kunze, Alabama lip fern. Native, perennial. Frequent on limestone in mesic wooded canyons. Bell Co.: LS 2107, Coryell Co.: LS 2067

Cheilanthes horridula Maxon, rough lip fern. Native, perennial. Rare on limestone in mesic wooded canyons. Bell Co.: LH 5538, Coryell Co.: **LH 6564**

Pellaea atropurpurea (L.) Link, purple cliff-brake. Native, perennial. Frequent on limestone in mesic wooded canyons. Bell Co.: JS 4228, Coryell Co.: **LS 2749**

Thelypteridaceae

Thelypteris kunthii (Desv.) Morton, Kunth's maiden fern. Native, perennial. Frequent in shade along banks of creeks and seeping limestone of mesic canyons. Bell Co.: LS 2720, Coryell Co.: **LS 3967**

CONIFEROPHYTA

Cupressaceae

Juniperus ashei Buchh., Ashe's juniper. Native, perennial. Common in most habitats, especially rocky limestone. Bell Co.: GG 345, Coryell Co.: LS 2083

Juniperus pinchotii Sudworth, Pinchot's juniper. Native, perennial. Rare on dry rocky limestone slopes. Bell Co.: LH 6241

Juniperus virginiana L., eastern red-cedar. Native, perennial. Occasional along wooded riparian corridors. Bell Co.: **LH 4918**, Coryell Co.: **LH 6303**

Platycladus orientalis (L.) Franco, Oriental arbor-vitae. Introduced, perennial. Rare at old homesites and cemeteries, cultivated, persisting. Coryell Co.: **LS 2597**

Taxodium distichum (L.) Rich., bald cypress. Native, perennial. Rare along banks of a fishing pond, possibly a waif. Coryell Co.: **LH 6736**

MAGNOLIOPHYTA: Dicotyledonae

Acanthaceae

Dicliptera brachiata (Pursh) Spreng., branched foldwing. Native, perennial. Occasional in moist soil along wooded rivers and creeks. Bell Co.: LH 5130, Coryell Co.: **LH 5450**

Dyschoriste linearis (Torr. & A. Gray) Kuntze var. *linearis*, snakeherb. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LH 5907, Coryell Co.: LS 2421

Justicia americana (L.) Vahl, American water-willow. Native, perennial. Common along banks of rivers and creeks. Bell Co.: LS 2499, Coryell Co.: LS 2553

Ruellia drummondiana (Nees) A. Gray, Drummond's wild petunia. Native, perennial. Frequent in shade along riparian corridors. Bell Co.: LS 1979, Coryell Co.: **LS 4467**

Ruellia humilis Nutt., fringe-leaf wild petunia. Native, perennial. Frequent in partial shade of woodlands. Bell Co.: **LS 3962**, Coryell Co.: **LS 2872**

Ruellia metziae Tharp, Metz's wild petunia. Native, perennial. Frequent in grasslands and limestone outcrops. Bell Co.: **LH 5067**, Coryell Co.: **LH 5041**

Ruellia nudiflora (Engelm. & A. Gray) Urban var. *nudiflora*, violet wild petunia. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2932, Coryell Co.: **LS 3974**

Ruellia nudiflora (Engelm. & A. Gray) Urban var. *runyonii* (Tharp & F.A. Barkley) B.L. Turner, Runyon's wild petunia. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: **LH 5052**, Coryell Co.: **LH 5298**

Aceraceae

Acer grandidentatum Nutt. var. *sinuosum* (Rehder) Little, canyon maple. Native, perennial. Occasional in mesic limestone canyons. Bell Co.: LS 4482, Coryell Co.: LS 4624

Acer negundo L. var. *negundo*, box-elder. Native, perennial. Common along wooded riparian corridors. Bell Co.: LH 5619, Coryell Co.: **LS 3403**

Amaranthaceae

Alternanthera caracasana Kunth, mat chaff-flower. Native, perennial. Occasional in sandy soil and disturbed areas. Bell Co.: LH 6059, Coryell Co.: LH 5464

Amaranthus albus L., tumbleweed. Introduced, annual. Occasional on banks of creeks and other disturbed areas. Bell Co.: LS 2920, Coryell Co.: **LS 4473**

Amaranthus blitoides S. Watson, prostrate pigweed. Introduced, annual. Occasional in disturbed areas. Bell Co.: CLGY 54437 (TEX), Coryell Co.: LH 6159

Amaranthus palmeri S. Watson, carelessweed. Native, annual. Occasional along roadsides and in disturbed areas. Coryell Co.: **LS 3898**

Amaranthus polygonoides L., tropical amaranth. Native, annual. Rare on sandy Pleistocene terrace deposits and disturbed areas. Bell Co.: **LH 6065**

Amaranthus retroflexus L., red-root amaranth. Introduced, annual. Rare in disturbed areas. Bell Co.: CLGY 55269 (HABAYC), Coryell Co.: **LS s.n.**

Amaranthus tuberculatus (Moq.) Sauer, rough-fruit amaranth. Native, annual. Rare in disturbed areas. Bell Co.: SJC T41 (LL)

Froelichia gracilis (Hook.) Moq., slender snake-cotton. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: CLGY 55109 (HABAYC), Coryell Co.: **LH 6154**

Gossypianthus lanuginosus (Poir.) Moq. var. *lanuginosus*, cotton-flower. Native, perennial. Occasional in sandy soil and disturbed areas. Bell Co.: **CLGY 54340** (HABAYC), Coryell Co.: **LS 4474**

Iresine rhizomatosa Standl., Juda's bush. Native, perennial. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 5544**

Anacardiaceae

Rhus glabra L., smooth sumac. Native, perennial. Rare, known from one old homesite, cultivated, persisting. Bell Co.: LS 3425

Rhus lanceolata (A. Gray) Britton, flame-leaf sumac. Native, perennial. Common in most habitats, especially in sunny disturbed areas. Bell Co.: LS 2919, Coryell Co.: LS 2615

Rhus trilobata Nutt., skunkbush sumac. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LS 2202, Coryell Co.: **LS 2637**

Rhus virens Lindh. ex A. Gray var. *virens*, evergreen sumac. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: GG 344, Coryell Co.: LH 5330

Toxicodendron radicans (L.) Kuntze ssp. *verrucosum* (Scheele) Gillis, poison-ivy. Native, perennial. Common in most woodlands. Bell Co.: **LS 2221**, Coryell Co.: LS 2663

Apiaceae

Ammoselinum popei Torr. & A. Gray, plains sand-parsley. Native, annual. Rare in shade along banks of creeks. Bell Co.: **LH 5838**

Bifora americana Benth. & Hook. f. ex S. Watson, prairie-bishop. Native, annual. Common in grasslands. Bell Co.: LS 2323, Coryell Co.: LS 2533

Chaerophyllum tainturieri Hook. var. *dasycarpum* Hook. ex S. Watson, hairy-fruit chervil. Native, annual. Common in most habitats, especially shaded areas. Bell Co.: LS 2336, Coryell Co.: LS 2264

Chaerophyllum tainturieri Hook. var. *tainturieri*, chervil. Native, annual. Common in most habitats, especially shaded areas. Bell Co.: LS 2214, Coryell Co.: LS 2245

Cyclospermum leptophyllum (Pers.) Sprague ex Britton & P. Wilson, slim-lobe celery. Introduced, annual. Frequent in damp soils and gravelly alluvium. Bell Co.: LS 3254, Coryell Co.: **LS 2546**

Cymopterus macrorhizus Buckley, big-root wavewing. Native, perennial. Rare in grasslands on rocky limestone. Bell Co.: **LH 6716**,Coryell Co.: **LS 2122**

Daucosma laciniata **Englem. & A. Gray,** meadow parasol. Native, annual. Rare in partial shade at woodland edges. Bell Co.: LH 6618

Daucus carota L., wild carrot. Introduced, biennial. Occasional along roadsides, rapidly spreading. Bell Co.: **LH 6636**, Coryell Co.: **LH 4901**

Daucus pusillus Michx., rattlesnake-weed. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 2477, Coryell Co.: **LS 2437**

Eryngium hookeri Walp., Hooker's eryngo. Native, annual. Rare in damp soil of open grassland. Bell Co.: LH 5282

Eryngium leavenworthii Torr. & A. Gray, Leavenworth's eryngo. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LH 5280, Coryell Co.: **LS 2001**

Hydrocotyle prolifera Kellogg, whorled marshpennywort. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2711

Hydrocotyle umbellata L., water-pennywort. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: **LS 4289**, Coryell Co.: LH 5556

Hydrocotyle verticillata Thunb. var. *verticillata*, whorled water-pennywort. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 1963, Coryell Co.: **LS 1942**

Limnosciadium pumilum (Engelm. & A. Gray) Mathias & Constance, prairie dogshade. Native, annual. Rare in mud around a pond. Bell Co.: **LH 5909**

Polytaenia nuttallii DC., prairie-parsley. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2387, Coryell Co.: **LS 1906**

Sanicula canadensis L., black snakeroot. Native, perennial. Common in shade along riparian corridors. Bell Co.: LS 2801, Coryell Co.: **LS 2546**

Spermolepis divaricata (Walter) Raf. ex Ser., rough-fruit scale-seed. Native, annual. Occasional on sandy soils and post oak woodlands. Bell Co.: CLY s.n. (HABAYC), Coryell Co.: **LH 6797**

Spermolepis echinata (Nutt. ex DC.) A. Heller, beggar's-lice. Native, annual. Occasional on sandy soil and post oak woodlands. Coryell Co.: **LH 6798**

Spermolepis inermis (Nutt. ex DC.) Mathias & Constance, spreading scale-seed. Native, annual. Common in grasslands and open woodlands. Bell Co.: **LS 3259**, Coryell Co.: **LH 6799**

Torilis arvensis (Huds.) Link, spreading hedge-parsley. Introduced, annual. Common in disturbed areas. Bell Co.: LS 2574, Coryell Co.: LS 2417

Torilis nodosa (L.) Gaertn., knotted hedge-parsley. Introduced, annual. Frequent in disturbed areas and lawns. Bell Co.: LS 1788, Coryell Co.: **LS 2555**

Trepocarpus aethusae Nutt. ex DC., whitenymph. Native, annual. Rare in shade along banks of creeks. Bell Co.: **LH 6051**, Coryell Co.: **LH 6549**

Apocynaceae

Amsonia ciliata Walter, Texas blue-star. Native, perennial. Frequent in grasslands on rocky limestone. Bell Co.: **LS 4647**, Coryell Co.: **LH 5897**

Amsonia longiflora Torr. var. *salpignantha* (Woodson) S.P. McLaughlin, trumpet slimpod. Native, perennial. Rare in grasslands on dry rocky limestone. Bell Co.: LS 4654

Apocynum cannabinum L., Indian-hemp. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: **LS 3279**, Coryell Co.: LH 5947

Asclepias asperula (Decne.) Woodson ssp. *capricornu* (Woodson) Woodson, antelope-horns. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2198, Coryell Co.: LS 1900

Asclepias engelmanniana Woodson, Engelmann's milkweed. Native, perennial. Rare in seasonally seeping limestone grasslands. Bell Co.: **LH 5156**

Asclepias oenotheroides Cham. & Schltdl., side-cluster milkweed. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2767, Coryell Co.: **LS 3309**

Asclepias texana A. Heller, Texas milkweed. Native, perennial. Rare in wooded canyons and slopes. Bell Co.: **LS 4391**

Asclepias verticillata L., whorled milkweed. Native, perennial. Rare on sandy soils and post oak woodlands. Bell Co.: LS 742, Coryell Co.: **LS 2609**

Asclepias viridiflora Raf., wand milkweed. Native, perennial. Frequent in grasslands and open woodlands over dry rocky limestone. Bell Co.: **LH 5044**, Coryell Co.: **LS 4423**

Asclepias viridis Walter, green milkweed. Native, perennial. Frequent in grasslands. Bell Co.: **LS 2846**, Coryell Co.: **LS 3389**

Cynanchum barbigerum (Scheele) Shinners, bearded swallow-wort. Native, perennial. Occasional on limestone slopes and mesatops, climbing onto shrubs. Bell Co.: **LS 4481**

Cynanchum racemosum (Jacq.) Jacq. var. *unifarium* (Scheele) E. Sundell, talayote. Native, perennial. Occasional in post oak woodlands and sandy alluvium, climbing onto shrubs. Coryell Co.: **LH 5457**

Funastrum crispum (Benth.) Schltr., wavy-leaf twinevine. Native, perennial. Frequent in open woodlands, climbing onto shrubs. Bell Co.: **LS 3261**, Coryell Co.: **LS 1492**

Funastrum cynanchoides (Decne.) Schltr. ssp. *cynanchoides*, fringed twinevine. Native, perennial. Rare in sandy soils and disturbed areas, climbing onto shrubs. Coryell Co.: **LH 6158**

Matelea biflora (Raf.) Woodson, purple milkvine. Native, perennial. Frequent in grasslands, especially over sand. Bell Co.: **LS 3249**, Coryell Co.: LS 1426

***Matelea edwardsensis* Correll,** Plateau milkvine. Native, perennial. Common on rocky limestone slopes and mesatops, climbing onto shrubs and trees. Bell Co.: LS 2332, Coryell Co.: LS 2669

Matelea gonocarpos (Walter) Shinners, anglepod. Native, perennial. Frequent on mesic limestone slopes and canyons, climbing onto shrubs and trees. Bell Co.: LH 5112, Coryell Co.: **LS 3392**

Matelea reticulata (Engelm. ex A. Gray) Woodson, net-vein milkvine. Native, perennial. Common on rocky limestone slopes and mesatops, climbing onto shrubs and trees. Bell Co.: JS 4221, Coryell Co.: LH 5008

Vinca major L., big-leaf periwinkle. Introduced, perennial. Frequent near old homesites, cultivated, naturalized. Bell Co.: LS 4595, Coryell Co.: **LS 4611**

Aquifoliaceae

Ilex decidua Walter, deciduous holly. Native, perennial. Common along banks of creeks, in mesic canyons, and in woodlands. Bell Co.: LS 2517, Coryell Co.: LH 4664

Ilex vomitoria Aiton, yaupon. Native, perennial. Occasional in woodlands. Bell Co.: **LH 5678**, Coryell Co.: **LS 3541**

Aristolochiaceae

Aristolochia serpentaria L., Virginia Dutchman's pipe. Native, perennial. Frequent on limestone in mesic wooded canyons. Bell Co.: LS 1498, Coryell Co.: LH 4905

Asteraceae

Achillea millefolium L., western yarrow. Native, perennial. Occasional in open woodlands. Bell Co.: CLGY 55074 (HABAYC), Coryell Co.: **LS 2565**

Acmella oppositifolia (Lam.) R.K. Jansen var. *repens* (Walter) R.K. Jansen, opposite-leaf spotflower. Native, perennial. Rare in shade along riparian corridors. Coryell Co.: **LH 5307**

Ageratina havanensis (Kunth) King & H.E. Robins., shrubby boneset. Native, perennial. Rare on limestone in mesic wooded canyons. Bell Co.: LH 5006

Ambrosia artemisiifolia L., common ragweed. Native, annual. Common in disturbed grasslands, especially in sandy soil. Bell Co.: LS 2974, Coryell Co.: LS 2960

Ambrosia psilostachya DC., western ragweed. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2953, Coryell Co.: LS 2913

Ambrosia trifida L. var. *texana* Scheele, Texas giant ragweed. Native, annual. Common in disturbed areas, especially in moist soil. Bell Co.: **LS 2997**, Coryell Co.: **LS 3441**

***Amphiachyris amoena* (Shinners) Solbrig**, Texas broomweed. Native, annual. Common in disturbed grasslands. Bell Co.: CLGY 53145 (HABAYC)

Amphiachyris dracunculoides (DC.) Nutt., common broomweed. Native, annual. Common in disturbed grasslands. Bell Co.: LH 6264, Coryell Co.: LH 6260

Anthemis cotula L., stinking chamomile. Introduced, annual. Rare at an old homesite, cultivated, not persisting. Bell Co.: SEW 3515 (TEX)

Aphanostephus skirrhobasis (DC.) Trel. var. *skirrhobasis*, Arkansas lazy daisy. Native, annual. Frequent in sandy soils and post oak woodlands. Coryell Co.: LH 6610

Arnoglossum plantagineum Raf., Indian plantain. Native, perennial. Frequent in sandy soils and post oak woodlands. Bell Co.: LH 5929, Coryell Co.: **LH 5877**

Artemisia ludoviciana Nutt. ssp. *mexicana* (Willd. ex Spreng.) Keck, Mexican sagebrush. Native, perennial. Common in partial shade at woodland edges. Bell Co.: LH 5525, Coryell Co.: LS 2093

Baccharis neglecta Britton, Roosevelt-weed. Native, perennial. Common in disturbed areas. Bell Co.: LS 2993, Coryell Co.: LS 3442

Baccharis texana (Torr. & A. Gray) A. Gray, prairie false willow. Native, perennial. Rare in a post oak woodland. Bell Co.: LH 6245

Bidens frondosa L., beggar-ticks. Native, annual. Common along banks of creeks and ponds. Bell Co.: **LH 6161**, Coryell Co.: **LS 4501**

Brickellia cylindracea A. Gray & Engelm., gravel-bar brickellbush. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LH 6240, Coryell Co.: LH 5328

Brickellia eupatorioides (L.) Shinners var. *texana* (Shinners) Shinners, prairie kuhnia. Native, perennial. Common in limestone grasslands. Bell Co.: LH 5532, Coryell Co.: LS 4494

Calyptocarpus vialis Less., straggler daisy. Native, perennial. Common in shaded disturbed areas, especially along riparian corridors. Bell Co.: LS 1789, Coryell Co.: **LS 2829**

Carduus nutans L., nodding plumeless thistle. Introduced, annual or biennial. Rare on roadside shoulder, seeded area, cultivated, persisting. Bell Co.: **LH 5894**

Carduus tenuiflorus W. Curtis, slender bristle-thistle. Introduced, annual or biennial. Occasional in disturbed areas. Bell Co.: LS 2776, Coryell Co.: LH 5754

Carthamus lanatus L., woolly distaff thistle. Introduced, annual. Occasional in disturbed grasslands. Bell Co.: **LH 4966**, Coryell Co.: WRC 17589

Centaurea americana Nutt., American basket-flower. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LH 6602, Coryell Co.: **LS 2433**

Centaurea melitensis L., Maltese star-thistle. Introduced, annual. Frequent in disturbed areas. Bell Co.: LS 2764, Coryell Co.: LH 6476

Chaetopappa asteroides Nutt. ex DC., common least daisy. Native, annual. Frequent in grasslands and open woodlands. Bell Co.: LS 1676, Coryell Co.: LH 5675

***Chaetopappa bellidifolia* (A. Gray & Engelm.) Shinners,** dwarf white aster. Native, annual. Frequent on rocky limestone mesatops, and in mesic riparian corridors and canyons. Bell Co.: LH 5939, Coryell Co.: **LH 5063**

Chloracantha spinosa (Benth.) G.L. Nesom, Mexican devilweed. Native, perennial. Rare on damp soil and roadside ditches. Bell Co.: **LS 2992**, Coryell Co.: **LH 6249**

Cirsium texanum Buckley, Texas thistle. Native, biennial or perennial. Common in grasslands and open woodlands. Bell Co.: LH 5931, Coryell Co.: LS 2440

Cirsium undulatum (Nutt.) Spreng., wavy-leaf thistle. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 3298, Coryell Co.: LS 3285

Cirsium vulgare (Savi) Ten., bull thistle. Introduced, biennial. Rare in disturbed areas. Bell Co.: **LH 6066**

Conoclinium coelestinum (L.) DC., blue mistflower. Native, perennial. Common on damp soil along banks of creeks and ponds. Bell Co.: LS 1984, Coryell Co.: **LS 4502**

Conyza canadensis (L.) Cronquist var. *canadensis*, Canadian horseweed. Native, annual. Common in gravelly alluvium and disturbed areas. Bell Co.: LH 5289, Coryell Co.: LH 6071

Conyza canadensis (L.) Cronquist var. *glabrata* (A. Gray) Cronquist, horseweed. Native, annual. Common in gravelly alluvium and disturbed areas. Bell Co.: LS 2921, Coryell Co.: LS 4508

Coreopsis tinctoria Nutt., plains coreopsis. Native, annual. Common in grasslands. Bell Co.: LS 2762, Coryell Co.: **LS 2746**

Coreopsis wrightii (A. Gray) H.M. Parker, rock tickseed. Native, annual. Frequent in grasslands and open woodlands. Bell Co.: **LH 5906**, Coryell Co.: **LH 6545**

Crepis pulchra L., small-flower hawk's-beard. Introduced, annual. Rare on disturbed roadside shoulders. Bell Co.: **LH 5893**, Coryell Co.: **LH 5840**

Dracopis amplexicaulis (Vahl) Cass., clasping coneflower. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: LS 2793, Coryell Co.: **LH 5943**

Dysodiopsis tagetoides (Torr. & A. Gray) Rydb., marigold dogweed. Native, perennial. Frequent in grasslands on dry rocky limestone. Bell Co.: LS 3574, Coryell Co.: LS 4432

Echinacea angustifolia DC., blacksamson echinacea. Native, perennial. Rare in grasslands on dry rocky limestone. Coryell Co.: **LS 2403**

Eclipta prostrata (L.) L., pieplant. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2938, Coryell Co.: **LS 4396**

Elephantopus carolinianus Raeusch., leafy elephantopus. Native, perennial. Occasional in shade along riparian corridors. Bell Co.: **LS 1960**, Coryell Co.: **LS 4436**

Engelmannia peristenia (Raf.) Goodman & C.A. Lawson, Engelmann's daisy. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2497, Coryell Co.: GG 368

Erechtites hieraciifolia (L.) Raf. ex DC., American burnweed. Native, annual. Rare in disturbed bottomlands. Coryell Co.: SMKL 488 (CMML)

Erigeron modestus A. Gray, plains fleabane. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LH 5609, Coryell Co.: **LH 5608**

Erigeron philadelphicus L., Philadelphia fleabane. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 4656, Coryell Co.: **LS 2256**

Erigeron strigosus Muhl. ex Willd. var. *strigosus*, prairie fleabane. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2308, Coryell Co.: LH 5670

Erigeron tenuis Torr. & A. Gray, slender fleabane. Native, annual or biennial. Common in open woodlands. Bell Co.: LS 3572, Coryell Co.: **LS 2081**

Eupatorium serotinum Michx., white boneset. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2990, Coryell Co.: **LS 4468**

Evax prolifera Nutt. ex DC., big-head evax. Native, annual. Common in disturbed grasslands. Bell Co.: LS 1686, Coryell Co.: LS 2261

Evax verna Raf., many-stem evax. Native, annual. Common in disturbed grasslands. Bell Co.: LH 4961, Coryell Co.: **LH 4898**

Gaillardia pulchella Foug. var. *pulchella*, Indian-blanket. Native, annual. Common in grasslands. Bell Co.: LH 6474, Coryell Co.: **LS 2426**

Gaillardia suavis (A. Gray & Engelm.) Britton & Rusby, rayless gaillardia. Native, perennial. Rare in open woodlands. Bell Co.: CLGY 54340 (HABAYC), Coryell Co.: **LH 5751**

Gamochaeta antillana (Urban) Anderberg, delicate everlasting. Introduced, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: LH 6803

Gamochaeta pensylvanica (Willd.) Cabrera, Pennsylvania everlasting. Introduced, annual or biennial. Occasional on sandy Pleistocene terrace deposits. Coryell Co.: **LS 1908**

Gamochaeta purpurea (L.) Cabrera, spoon-leaf purple everlasting. Native, annual. Occasional on sandy Pleistocene terrace deposits. Coryell Co.: **LH 5674**

Grindelia lanceolata Nutt. var. *texana* (Scheele) Shinners, Texan gumweed. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 3960, Coryell Co.: LS 4427

Grindelia nuda Wood var. *nuda*, curlytop gumweed. Native, annual. Frequent in disturbed grasslands. Bell Co.: **LS 2984**, Coryell Co.: **LS 2099**

Gutierrezia texana (DC.) Torr. & A. Gray var. *texana*, Texas broomweed. Native, annual. Common in disturbed grasslands. Bell Co.: LS 2041, Coryell Co.: LH 6259

Hedypnois cretica (L.) Dum. Cours., Cretan weed. Introduced, annual. Rare on disturbed roadside shoulders. Bell Co.: **LH 5607**, Coryell Co.: **LH 5623**

Helenium amarum (Raf.) H. Rock var. *amarum*, yellow bitterweed. Native, annual. Common on sandy Pleistocene terrace deposits. Bell Co.: LH 5386, Coryell Co.: LS 2757

Helenium autumnale L., fall sneezeweed. Native, perennial. Common on damp soil along banks of creeks. Bell Co.: LS 2048, Coryell Co.: **LH 5470**

Helenium elegans DC. var. *elegans*, elegant sneezeweed. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: **LS 2723**, Coryell Co.: **LS 2831**

Helenium microcephalum DC. var. *microcephalum*, small-head sneezeweed. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2797, Coryell Co.: LS 3395

Helianthus annuus L., common sunflower. Native, annual. Common in disturbed grasslands and along roadsides. Bell Co.: LH 5047, Coryell Co.: **LS 2875**

Helianthus maximiliani Schrad., Maximilian sunflower. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2994, Coryell Co.: LH 5377

Heterotheca canescens (DC.) Shinners, gray gold-aster. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 3577, Coryell Co.: LS 4426

Heterotheca subaxillaris (Lam.) Britton & Rusby, camphorweed.

Native, annual or biennial. Common in open woodlands, roadsides, and disturbed areas. Bell Co.: LH 5462, Coryell Co.: **LS 4510**

Hymenopappus scabiosaeus L'Her. var. *corymbosus* (Torr. & A. Gray) B.L. Turner, Carolina woolly-white. Native, biennial. Common in grasslands and open woodlands. Bell Co.: LS 1707, Coryell Co.: LS 2432

Hymenopappus tenuifolius Pursh, chalkhill. Native, biennial. Common on dry rocky limestone. Bell Co.: LH 5043, Coryell Co.: LS 2523

Hypochaeris brasiliensis (Less.) Benth. & Hook. ex Griseb., Brazilian cat's ear. Introduced, biennial. Rare in disturbed areas. Coryell Co.: **LS 2451**

Iva angustifolia Nutt. ex DC., narrow-leaf sumpweed. Native, annual. Common in disturbed grasslands and in moist soil along banks of creeks. Bell Co.: **LS 2952**, Coryell Co.: **LS 3444**

Iva annua L., annual marsh-elder. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2988, Coryell Co.: **LS 4503**

Krigia caespitosa (Raf.) Chambers, dwarf dandelion. Native, annual. Frequent in damp soil of disturbed areas. Bell Co.: LH 5642, Coryell Co.: LH 6375

Krigia wrightii (A. Gray) K.L. Chambers ex K.J. Kim, Wright's dwarf dandelion. Native, annual. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LH 5598**

Lactuca floridana (L.) Gaertn., woodland lettuce. Native, annual. Frequent along riparian corridors. Bell Co.: LS 1983, Coryell Co.: **LH 5191**

Lactuca ludoviciana (Nutt.) Riddell, western wild lettuce. Native, biennial. Common in woodlands and along riparian corridors. Bell Co.: LS 3264, Coryell Co.: LS 2744

Lactuca serriola L., prickly lettuce. Introduced, annual. Common in disturbed areas. Bell Co.: **LH 4993**, Coryell Co.: LS 4507

Laennecia coulteri (A. Gray) G.L. Nesom, Coulter's horseweed. Native, annual. Rare in disturbed alluvial floodplain. Bell Co.: **LH 6246**

Liatris aestivalis G.L. Nesom & R. O'Kennon, summer gayfeather. Native, perennial. Frequent in grasslands on dry rocky limestone. Bell Co.: **LH 5373**, Coryell Co.: LS 2003

Liatris mucronata DC., narrow-leaf gayfeather. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 2054, Coryell Co.: LS 4493

Lindheimera texana A. Gray & Engelm., Texas-star. Native, annual. Common in grasslands. Bell Co.: LS 1881, Coryell Co.: LS 2453

Lygodesmia texana (Torr. & A. Gray) Greene, Texas skeletonplant. Native, perennial. Common in grasslands. Bell Co.: LS 2693, Coryell Co.: LS 2673

Marshallia caespitosa Nutt. ex DC. var. *signata* Beadle & F.E. Boynt., Barbara's buttons. Native, perennial. Common in grasslands on rocky limestone, especially in seepy areas. Bell Co.: LS 1777, Coryell Co.: LS 2428

Melampodium leucanthum Torr. & A. Gray, rock daisy. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 1852, Coryell Co.: LS 2286

Onopordum acanthium L., cotton-thistle. Introduced, biennial. Rare on roadside shoulder. Bell Co.: **LS 3562**

Packera obovata (Muhl. ex Willd.) W.A. Weber & A. Love, round-leaf groundsel. Native, perennial. Frequent in mesic woodlands and canyons. Bell Co.: **LH 5588**, Coryell Co.: **KSNH 731**

Packera tampicana (DC.) C. Jeffrey, Great Plains ragwort. Native, annual. Frequent in damp open areas and roadside ditches. Bell Co.: **LH 5688**, Coryell Co.: LH 5853

Palafoxia callosa (Nutt.) Torr. & A. Gray, small palafoxia. Native, annual. Common in disturbed grasslands. Bell Co.: LS 2046, Coryell Co.: LS 4430

Parthenium hysterophorus L., false ragweed. Native, annual. Common in disturbed grasslands. Bell Co.: LH 5056, Coryell Co.: **LS 4476**

***Pectis angustifolia* Torr. var. *fastigiata* (A. Gray) Keil**, lemonscent. Native, annual. Occasional in shallow pockets of soil on limestone outcrops and mesatops. Bell Co.: LH 5326, Coryell Co.: LH 5064

Pinaropappus roseus (Less.) Less., white rock lettuce. Native, perennial. Rare on rocky limestone. Bell Co.: LH 6418, Coryell Co.: **LH 5871**

Pluchea camphorata (L.) DC., camphorweed. Native, annual or perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5267, Coryell Co.: **LH 5306**

Pluchea odorata (L.) Cass., sweetscent. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2989, Coryell Co.: LS 4437

Pseudognaphalium obtusifolium (L.) Hilliard & B.L. Burtt, fragrant cud-weed. Native, annual. Frequent in woodlands of limestone slopes and adjacent mesatops. Bell Co.: **LH 5399**, Coryell Co.: **LH 5258**

Pyrrhopappus grandiflorus (Nutt.) Nutt., tuber false dandelion. Native, perennial. Occasional on sandy Pleistocene terrace deposits. Coryell Co.: **LH 5673**

Pyrrhopappus pauciflorus (D. Don) DC., Texas dandelion. Native, annual. Common in grasslands and mesic woodlands. Bell Co.: LS 2215, Coryell Co.: LS 2251

Ratibida columnifera (Nutt.) Woot. & Standl., Mexican hat. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2496, Coryell Co.: LS 2424

Rudbeckia hirta L. var. *pulcherrima* Farw., black-eyed Susan. Native, annual or perennial. Common in grasslands and open woodlands. Bell Co.: LS 2577, Coryell Co.: LS 3373

***Silphium albiflorum* A. Gray,** white rosinweed. Native, perennial. Common on dry rocky limestone. Bell Co.: LS 3573, Coryell Co.: LS 4424

Silphium laciniatum L., compassplant. Native, perennial. Rare on dry rocky limestone. Coryell Co.: **LS 1951**

Silphium radula Nutt., rough-stem rosinweed. Native, perennial. Common along riparian corridors. Bell Co.: LH 5045, Coryell Co.: LS 3977

Silybum marianum (L.) Gaertn., blessed milk-thistle. Introduced, annual or biennial. Occasional in disturbed areas. Bell Co.: LS 2809, Coryell Co.: **LH 6475**

Simsia calva (Engelm. & A. Gray) A. Gray, awnless bush-sunflower. Native, perennial. Common in open woodlands. Bell Co.: LS 1489, Coryell Co.: LS 2407

Smallanthus uvedalius (L.) Mack. ex Small, bear's foot. Native, perennial. Occasional in shade along riparian corridors. Bell Co.: LH 6097

Solidago altissima L., late goldenrod. Native, perennial. Common in damp soil along banks of creeks and in post oak woodlands. Bell Co.: LS 2995, Coryell Co.: LH 5468

Solidago gigantea Aiton, giant goldenrod. Native, perennial. Common in moist soil along banks of creeks and rivers. Bell Co.: LS 2059, Coryell Co.: **LS 4504**

Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) Palmer & Steyerm., gray goldenrod. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 2050, Coryell Co.: LS 2094

Solidago radula Nutt., western rough goldenrod. Native, perennial. Common on dry rocky limestone. Bell Co.: LS 2049, Coryell Co.: LS 2008

Sonchus asper (L.) Hill, spiny sow-thistle. Introduced, annual. Frequent in disturbed areas. Bell Co.: LS 1856, Coryell Co.: **LS 2236**

Sonchus oleraceus L., common sow-thistle. Introduced, annual. Rare in disturbed areas. Bell Co.: LH 6339, Coryell Co.: **LH 5001**

Symphyotrichum divaricatum (Nutt.) G.L. Nesom, wireweed. Native, annual. Common along banks of creeks, ponds, and other damp areas. Bell Co.: LS 4587, Coryell Co.: **LS 4506**

Symphyotrichum drummondii (Lindl.) G.L. Nesom var. *texanum* (Burgess) G.L. Nesom, Texas aster. Native, perennial. Common in shade along riparian corridors and mesic canyons. Bell Co.: LS 2516, Coryell Co.: LH 5476

Symphyotrichum ericoides (L.) G.L. Nesom var. *ericoides*, white heath aster. Native, perennial. Common in grasslands. Bell Co.: LS 4589, Coryell Co.: LH 5469

Symphyotrichum oblongifolium (Nutt.) G.L. Nesom, aromatic aster. Native, perennial. Rare in sandy soil. Coryell Co.: LS 2084

Symphyotrichum praealtum (Poir.) G.L. Nesom, willow-leaf aster. Native, perennial. Frequent in moist soils and along unshaded creek banks. Bell Co.: **LS 4588**, Coryell Co.: LH 6305

Symphyotrichum sericeum (Vent.) G.L. Nesom, silky aster. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: **LS 4593**, Coryell Co.: LS 3634

Taraxacum officinale F.H. Wigg., common dandelion. Introduced, biennial or perennial. Common in disturbed areas and lawns. Bell Co.: LS 1695, Coryell Co.: **LS 4599**

Tetraneuris linearifolia (Hook.) Greene, slender-leaf bitterweed. Native, annual. Common in grasslands and on limestone mesatops. Bell Co.: LH 6414, Coryell Co.: LS 2903

Tetraneuris scaposa (DC.) Greene var. *scaposa*, slender-stem bitterweed. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 2129, Coryell Co.: LS 2252

Thelesperma filifolium (Hook.) A. Gray var. *filifolium*, stiff greenthread. Native, annual or perennial. Common in grasslands and open woodlands. Bell Co.: LS 3250, Coryell Co.: LS 2413

Thelesperma simplicifolium A. Gray, slender greenthread. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2498, Coryell Co.: 2498

Thymophylla pentachaeta (DC.) Small, common dogweed. Native, perennial. Frequent in grasslands on rocky limestone and disturbed areas. Bell Co.: **LS 1672**, Coryell Co.: **LH 5559**

Townsendia exscapa (Richardson) Porter, stemless Townsend daisy. Native, perennial. Rare in grasslands on rocky limestone. Bell Co.: LH 5574, Coryell Co.: LH 5566

Tragopogon dubius Scop., yellow salsify. Introduced, biennial. Rare in disturbed area. Bell Co.: **LH 6635**

Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray, cowpen daisy. Native, annual. Frequent in grasslands and disturbed areas. Bell Co.: **LH 5394**, Coryell Co.: **LS 2023**

***Verbesina lindheimeri* B.L. Rob. & Greenm.,** Lindheimer's crownbeard. Native, perennial. Rare in wooded canyons and slopes. Bell Co.: LH 5161, Coryell Co.: LS s.n.

Verbesina virginica L., frostweed. Native, perennial. Common in shade of woodlands and riparian corridors. Bell Co.: LS 1976, Coryell Co.: **LH 5275**

Vernonia baldwinii Torr. ssp. *interior* (Small) Faust, western ironweed. Native, perennial. Common in moist soil along banks of creeks and rivers. Bell Co.: LS 2947, Coryell Co.: **LS 4495**

Vernonia x *guadalupensis* A. Heller (pro sp.) [*baldwinii* x *lindheimeri*], hybrid ironweed. Native, perennial. Frequent in grasslands and along banks of creeks. Bell Co.: **LH 5144**, Coryell Co.: **LH 5274**

Vernonia lindheimeri A. Gray & Engelm., woolly ironweed. Native, perennial. Common on dry rocky limestone. Bell Co.: LS 3575, Coryell Co.: LH 5482

Viguiera dentata (Cav.) Spreng., golden-eye. Native, perennial. Common at woodland edges on limestone. Bell Co.: LH 5397, Coryell Co.: LH 4997

Wedelia texana (A. Gray) B.L. Turner, hairy wedelia. Native, perennial. Rare in grasslands and open woodlands. Bell Co.: **LH 5942**

Xanthisma texanum DC. ssp. *drummondii* (Torr. & A. Gray) Semple, Texas sleepy daisy. Native, annual. Rare among construction debris, possibly a waif. Bell Co.: **LH 5055**

Xanthium strumarium L. var. *canadense* (Mill.) Torr. & Gray, Canada cocklebur. Native, annual. Common along banks of creeks, ponds, and other damp areas. Bell Co.: LS 2991, Coryell Co.: **LS 2017**

Berberidaceae

Mahonia trifoliolata (Moric.) Fedde, agarita. Native, perennial. Common in grasslands and woodlands on dry rocky limestone. Bell Co.: LS 4629, Coryell Co.: **LS 2635**

Nandina domestica Thunb., sacred bamboo. Introduced, perennial. Occasional near old homesites, cultivated, naturalized. Bell Co.: **LS 2104**, Coryell Co.: **LS 4191**

Bignoniaceae

Campsis radicans (L.) Seem. ex Bureau, common trumpet-creeper. Native, perennial. Occasional near old homesites, cultivated, naturalized. Bell Co.: LS 759, Coryell Co.: **LH 6638**

Catalpa speciosa (Warder) Warder ex Engelm., northern catalpa. Native, perennial. Rare along banks of creek, possibly a waif, persisting. Coryell Co.: **LH 5291**

Chilopsis linearis (Cav.) Sweet, desert willow. Native, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LS 2837**

Boraginaceae

Buglossoides arvensis (L.) I.M. Johnston, buglossoides. Introduced, annual. Frequent in disturbed grasslands and along roadsides. Bell Co.: LS 4634, Coryell Co.: **LS 4646**

***Cryptantha texana* (A. DC.) Greene,** pick-me-nots. Native, annual. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 6609**

Heliotropium indicum L., India heliotrope. Introduced, annual. Frequent in disturbed alluvial deposits of creeks and lakes. Bell Co.: LH 5528

Heliotropium procumbens Mill., heliotrope. Native, annual. Frequent in disturbed alluvial deposits of creeks and lakes. Bell Co.: LH 5179

Heliotropium tenellum (Nutt.) Torr., white heliotrope. Native, annual. Common in grasslands on rocky limestone. Bell Co.: LS 3980, Coryell Co.: LS 1952

Lithospermum incisum Lehm., narrow-leaf puccoon. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2766, Coryell Co.: LS 1817

Myosotis macrosperma Engelm., spring forget-me-not. Native, annual. Common in shade along riparian corridors. Bell Co.: LH 5646, Coryell Co.: LS 2263

Onosmodium bejariense DC. ex A. DC. var. *bejariense*, Bexar marbleseed. Native, perennial. Common along riparian corridors. Bell Co.: LH 5004, Coryell Co.: **LH 5123**

Brassicaceae

***Arabis petiolaris* (A. Gray) A. Gray,** Brazos rockcress. Native, annual. Rare in open woodlands. Bell Co.: **LH 6450**, Coryell Co.: **LH 6449**

Brassica juncea (L.) Czern., India mustard. Introduced, annual. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 5944**

Capsella bursa-pastoris (L.) Medik., shepherd's purse. Introduced, annual. Frequent in disturbed areas and lawns. Bell Co.: LH 6334, Coryell Co.: **LS 2237**

Cardamine parviflora L. var. *arenicola* (Britton) O.E. Schulz, sand bittercress. Native, annual. Frequent on sandy Pleistocene terrace deposits. Bell Co.: **LH 6718**, Coryell Co.: **LH 5591**

Descurainia pinnata (Walter) Britton ssp. *pinnata*, western tansy-mustard. Native, annual. Occasional on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 4666**

Draba brachycarpa Nutt. ex Torr. & A. Gray, short-pod draba. Native, annual. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LH 5595**

Draba cuneifolia Nutt. ex Torr. & A. Gray, wedge-leaf draba. Native, annual. Frequent in disturbed areas. Bell Co.: **LS 2113**, Coryell Co.: **LH 6311**

Draba platycarpa Torr. & A. Gray, broad-pod draba. Native, annual. Frequent along roadsides and in disturbed areas. Bell Co.: LS 2140, Coryell Co.: **LS 1437**

Erysimum capitatum (Douglas ex Hook.) Greene, plains erysimum. Native, biennial or perennial. Rare in post oak woodlands. Bell Co.: **LS 1473**

Erysimum repandum L., spreading erysimum. Introduced, annual. Rare sandy soils and disturbed areas. Coryell Co.: **KSNH 715**

Lepidium austrinum Small, southern pepperweed. Native, annual. Common in grasslands and disturbed areas. Bell Co.: **LS 2219**, Coryell Co.: **LS 2272**

Lepidium virginicum L., Virginia pepper-grass. Native, annual. Common in grasslands, open woodlands, and disturbed areas. Bell Co.: LS 2218, Coryell Co.: **LS 1713**

Lesquerella gordonii (A. Gray) S. Watson, Gordon's bladderpod. Native, annual. Frequent in grasslands and disturbed areas. Coryell Co.: **LS 1734**

Lesquerella gracilis (Hook.) S. Watson ssp. *gracilis*, white bladderpod. Native, annual. Common in grasslands, open woodlands, and disturbed areas. Bell Co.: LS 2381, Coryell Co.: LH 6377

***Lesquerella recurvata* (Engelm. ex A. Gray) S. Watson,** slender bladderpod. Native, annual. Common in grasslands, woodlands, and disturbed areas. Bell Co.: LH 6682, Coryell Co.: **LS 1889**

Myagrum perfoliatum L., bird's-eye cress. Introduced, annual. Occasional on sandy alluvium. Bell Co.: **LH 6341**

Nasturtium officinale W.T. Aiton, watercress. Introduced, perennial. Common along creek banks and other damp areas. Bell Co.: LH 6481, Coryell Co.: **LS 3394**

Rapistrum rugosum (L.) All., annual bastard-cabbage. Introduced, annual. Occasional in disturbed grasslands and along roadsides. Bell Co.: LH 6340, Coryell Co.: **LH 5545**

Rorippa sessiliflora (Nutt.) Hitchc., stalkless yellowcress. Native, annual. Common on damp sandy Pleistocene terrace deposits. Bell Co.: LH 6162, Coryell Co.: **LH 6344**

Sisymbrium irio L., rocket-mustard. Introduced, annual. Rare in disturbed areas and lawns. Coryell Co.: **LS 4601**

Sisymbrium officinale (L.) Scop., hedge-mustard. Introduced, annual. Rare in sandy soil and disturbed areas. Coryell Co.: **LH 5879**

Buddlejaceae

Polypremum procumbens L., juniper-leaf. Native, perennial. Frequent on sandy Pleistocene terrace deposits. Bell Co.: CLGY 55134 (HABAYC), Coryell Co.: **LS 4403**

Cactaceae

Coryphantha sulcata (Engelm.) Britton & Rose, pineapple cactus. Native, perennial. Occasional in grasslands and open woodlands. Bell Co.: **LS 749**, Coryell Co.: **LH 6571**

Cylindropuntia imbricata (Haw.) F.M. Knuth, tree cholla. Native, perennial. Rare at an old homesite, cultivated, persisting. Bell Co.: **LH 4908**

Cylindropuntia leptocaulis (DC.) F.M. Knuth, desert Christmas cactus. Native, perennial. Frequent near old homesites and disturbed areas. Bell Co.: LH 6203, Coryell Co.: **LS 743**

Echinocactus texensis Hopffer, horse crippler. Native, perennial. Rare on rocky limestone hills and in sandy soil. Bell Co.: **LH 6605**

Echinocereus reichenbachii (Terscheck ex Walp.) Haage ssp. *reichenbachii*, lace cactus. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: **LH 5935**, Coryell Co.: **LH 5936**

Escobaria missouriensis (Sweet) D.R. Hunt, Missouri foxtail cactus. Native, perennial. Occasional in grasslands and open woodlands. Bell Co.: **LS 2689**, Coryell Co.: **LH 6378**

Opuntia engelmannii Salm-Dyck ex Engelm. var. *lindheimeri* (Engelm.) Parfitt & Pinkava, Texas prickly-pear. Native, perennial. Common in grasslands, open woodlands, and disturbed areas. Bell Co.: LH 5184, Coryell Co.: LH 5855

Opuntia engelmannii Salm-Dyck ex Engelm. var. *linguiformis* (Griffiths) Parfitt & Pinkava, cow's-tongue prickly-pear. Native, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LH 5182**, Coryell Co.: **LS 3270**

Opuntia macrorhiza Engelm., plains prickly-pear. Native, perennial. Common on sandy soils and post oak woodlands. Bell Co.: **LH 5934**, Coryell Co.: **LS 1913**

Opuntia phaeacantha Engelm., brown-spine prickly-pear. Native, perennial. Common in grasslands, open woodlands, and disturbed areas. Bell Co.: **LH 5923**

Callitrichaceae

Callitriche heterophylla Pursh, two-headed water-starwort. Native, annual. Occasional in clear still water, submersed. Bell Co.: LH 5196, Coryell Co.: LH 6678

Campanulaceae

Lobelia cardinalis L., cardinal flower. Native, perennial. Frequent in moist soil along banks of creeks and rivers. Bell Co.: LH 6098, Coryell Co.: **LS 4505**

Triodanis biflora (Ruiz & Pavon) Green, small Venus' looking-glass. Native, annual. Frequent in post oak woodlands. Bell Co.: LH 6477, Coryell Co.: **LS 1505**

Triodanis coloradoensis (Buckley) McVaugh, Colorado River Venus' looking-glass. Native, annual. Frequent on limestone mesatops, slopes, and canyons. Bell Co.: LH 6471, Coryell Co.: **LH 6567**

Triodanis holzingeri McVaugh, Holzinger's Venus' looking-glass. Native, annual. Rare on sandy Pleistocene terrace deposits. Bell Co.: CLGY 54442 (HABAYC) , Coryell Co.: **LH 6796**

Triodanis perfoliata (L.) Nieuwl., clasping Venus' looking-glass. Native, annual. Frequent in open woodlands. Bell Co.: LH 5883, Coryell Co.: **LH 6565**

Capparaceae

Polanisia dodecandra (L.) DC. ssp. *trachysperma* (Torr. & A. Gray) Iltis, sandy-seed clammy-weed. Native, annual. Frequent in sand and gravelly alluvium. Coryell Co.: **LS 4399**

Caprifoliaceae

Abelia x *grandiflora* (Rovelli ex Andre) Rehder [*chinensis* x *uniflora*], glossy abelia. Introduced, perennial. Rare among construction debris, possibly a waif, not persisting. Bell Co.: **LS 803**

Lonicera albiflora Torr. & A. Gray, western white honeysuckle. Native, perennial. Common on limestone canyons and slopes, climbing onto shrubs. Bell Co.: LH 6338, Coryell Co.: **LH 4751**

Lonicera japonica Thunb., Japanese honeysuckle. Introduced, perennial. Common along streams and other damp sites, climbing onto shrubs, cultivated, naturalized. Bell Co.: **LS 2936**, Coryell Co.: LS 3282

Lonicera sempervirens L., coral honeysuckle. Native, perennial. Rare on limestone canyons and slopes, climbing onto shrubs. Coryell Co.: LH 5615

Sambucus nigra L. ssp. *canadensis* (L.) R. Bolli, common elderberry. Native, perennial. Common in woodlands along streams. Bell Co.: LH 5129, Coryell Co.: **LH 6029**

Symphoricarpos orbiculatus Moench, coral-berry. Native, perennial. Common in shade of woodlands and riparian corridors. Bell Co.: JS 4235, Coryell Co.: **LH 5192**

Viburnum rufidulum Raf., rusty blackhaw. Native, perennial. Common in most woodlands. Bell Co.: LS 2204, Coryell Co.: LS 2644

Caryophyllaceae

Arenaria benthamii Fenzl ex Torr. & A. Gray, hilly sandwort. Native, annual. Common on rocky limestone slopes and mesatops, and in disturbed areas. Bell Co.: LH 6473, Coryell Co.: LS 2416

Arenaria serpyllifolia L., thyme-leaved sandwort. Introduced, annual. Frequent in sandy soils, disturbed areas, and in lawns. Bell Co.: **LS 2345**, Coryell Co.: LS 4603

Cerastium brachypodum (Engelm. ex A. Gray) B.L. Rob., shortstalk chickweed. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 1702, Coryell Co.: **LS 4605**

Cerastium glomeratum Thuill., sticky chickweed. Introduced, annual. Common in grasslands and disturbed areas. Bell Co.: **LS 4650**, Coryell Co.: **LS 2276**

Paronychia virginica Spreng., Park's nailwort. Native, perennial. Frequent in shallow pockets of soil on limestone outcrops and mesatops. Bell Co.: LS 3963, Coryell Co.: **LH 5260**

Polycarpon tetraphyllum (L.) L., four-leaf manyseed. Introduced, annual. Occasional on sandy soils and in post oak woodlands. Coryell Co.: LS 3386

Silene antirrhina L., sleepy catchfly. Native, annual. Frequent in grasslands and open woodlands. Bell Co.: LS 2395, Coryell Co.: **LH 6532**

Stellaria media (L.) Vill. ssp. *media*, common chickweed. Introduced, annual. Common in grasslands, open woodlands, and other damp areas. Bell Co.: LS 4636, Coryell Co.: **LH 5753**

Stellaria media (L.) Vill. ssp. *pallida* (Dumort.) Asch. & Graebn., lesser chickweed. Introduced, annual. Frequent on sandy soils and damp areas. Bell Co.: **CLGY 54024** (HABAYC), Coryell Co.: **LS 2270**

Celastraceae

Euonymus atropurpurea Jacq. var. *atropurpurea*, eastern wahoo. Native, perennial. Rare in mesic woodlands along streams. Coryell Co.: LH 5120

Chenopodiaceae

Chenopodium album L., lamb's quarters. Introduced, annual. Frequent in disturbed areas. Bell Co.: **LS 4242**, Coryell Co.: LH 6253

Chenopodium ambrosioides L., Mexican tea. Introduced, annual. Frequent on sandy Pleistocene terrace deposits. Bell Co.: LH 6064, Coryell Co.: **LS 4438**

Chenopodium berlandieri Moq., pit-seed goosefoot. Native, annual. Rare in sandy soils and disturbed areas. Bell Co.: SJC T43 (TEX), Coryell Co.: **LS s.n.**

Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson, narrow-leaf goosefoot. Native, annual. Occasional in sandy soils and disturbed areas. Bell Co.: **RKGL 477**, Coryell Co.: **LS 4401**

Monolepis nuttalliana (Schutz.) Greene, Nuttall's povertyweed. Native, annual. Occasional in sandy soils and disturbed areas. Coryell Co.: **LH 6537**

Cistaceae

Helianthemum georgianum Chapm., Georgia rock-rose. Native, perennial. Frequent on sandy Pleistocene terrace deposits and post oak woodlands. Bell Co.: CLGY 55147 (HABAYC), Coryell Co.: **LH 5961**

Helianthemum rosmarinifolium Pursh, rosemary sun-rose. Native, perennial. Frequent on sandy Pleistocene terrace deposits and post oak woodlands. Coryell Co.: **LH 5963**

Lechea mucronata Raf., hairy pinweed. Native, perennial. Frequent on sandy Pleistocene terrace deposits and post oak woodlands. Bell Co.: CLGY 55145 (HABAYC), Coryell Co.: **LH 6156**

***Lechea san-sabeana* (Buckley) Hodgdon,** San Saba pinweed. Native, perennial. Frequent on sandy Pleistocene terrace deposits and post oak woodlands. Coryell Co.: LH 5841

Lechea tenuifolia Michx., narrow-leaf pinweed. Native, perennial. Frequent on sandy Pleistocene terrace deposits and post oak woodlands. Bell Co.: **LH 6050**, Coryell Co.: LH 5959

Convolvulaceae

Convolvulus arvensis L., field bindweed. Introduced, perennial. Rare on roadside shoulders and disturbed areas. Bell Co.: LS 4480, Coryell Co.: LH 6261

Convolvulus equitans Benth., gray bindweed. Native, perennial. Frequent in grasslands and open woodlands, especially in disturbed areas. Bell Co.: LS 3266, Coryell Co.: **LS 2732**

Dichondra carolinensis Michx., Carolina pony-foot. Native, perennial. Common in grasslands and open woodlands, especially in damp soil. Bell Co.: LS 1654, Coryell Co.: **LS 2830**

***Dichondra recurvata* Tharp & M.C. Johnst.,** oakwoods pony-foot. Native, perennial. Occasional on sandy Pleistocene terrace deposits. Coryell Co.: **LH 5875**

Evolvulus nuttallianus Schult., hairy evolvulus. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LH 6417, Coryell Co.: LS 2674

Evolvulus sericeus Sw., white evolvulus. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 1289, Coryell Co.: **LS 3391**

Ipomoea cordatotriloba Dennst. var. *cordatotriloba*, sharp-pod morning-glory. Native, perennial. Common in a variety of habitats, often climbing onto shrubs. Bell Co.: LS 2729, Coryell Co.: **LS 3381**

Ipomoea cordatotriloba Dennst. var. *torreyana* (A. Gray) D. Austin, Torrey's tievine. Native, perennial. Common in a variety of habitats, often climbing onto shrubs. Bell Co.: LH 6109, Coryell Co.: LS 3407

Ipomoea lacunosa L., pitted morning-glory. Native, annual. Common along creek banks and other damp areas, usually in sandy soil. Bell Co.: LH 6102, Coryell Co.: **LS 4489**

Cornaceae

Cornus drummondii C.A. Mey., rough-leaf dogwood. Native, perennial. Common in mesic woodlands along streams and in canyons. Bell Co.: LS 2389, Coryell Co.: **LS 2670**

Crassulaceae

Sedum nuttallianum Raf., yellow stonecrop. Native, annual. Common in seasonally damp pockets of soil on limestone outcrops and mesatops. Bell Co.: LH 4936, Coryell Co.: **LS 2737**

Sedum pulchellum Michx., Texas stonecrop. Native, annual. Frequent in seasonally damp pockets of soil on limestone outcrops and mesatops. Bell Co.: LH 5847, Coryell Co.: LH 5852

Cucurbitaceae

Cucurbita foetidissima Kunth, buffalo gourd. Native, perennial. Common in disturbed grasslands and open woodlands. Bell Co.: LS 2782, Coryell Co.: **LS 2450**

Cucurbita pepo L. var. *texana* (Scheele) D. Decker, Texas gourd. Native, annual. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LS 4509**

Ibervillea lindheimeri (A. Gray) Greene, balsam gourd. Native, perennial. Frequent in woodlands, climbing onto shrubs. Bell Co.: LH 5848, Coryell Co.: **LS 1884**

Melothria pendula L., meloncito. Native, perennial. Occasional in woodlands, climbing onto shrubs. Bell Co.: CR 66, Coryell Co.: **LH 5542**

Sicyos angulatus L., one-seed bur-cucumber. Native, annual. Occasional in woodlands along streams, climbing onto shrubs and trees. Bell Co.: LS 2791, Coryell Co.: **LH 6025**

Cuscutaceae

Cuscuta cuspidata Engelm., cusp dodder. Native, annual. Frequent in grasslands, parasitizing herbaceous plants. Coryell Co.: **LS 2014**

Cuscuta exaltata Englem., tree dodder. Native, annual. Frequent in woodlands, parasitizing woody plants. Bell Co.: LS 3981, Coryell Co.: LS 3401

Cuscuta indecora Choisy var. *indecora*, showy dodder. Native, annual. Frequent in grasslands and along creek banks, parasitizing herbaceous plants. Bell Co.: LH 6106, Coryell Co.: **LS 2566**

Cuscuta pentagona Engelm., field dodder. Native, annual. Frequent in grasslands and along creek banks, parasitizing herbaceous plants. Bell Co.: LH 5148, Coryell Co.: LH 5074

Ebenaceae

Diospyros kaki L. f., Japanese persimmon. Introduced, perennial. Occasional near old homesites, cultivated, naturalized. Coryell Co.: **LS 2572**

Diospyros texana Scheele, Texas persimmon. Native, perennial. Common in most woodlands. Bell Co.: LS 2222, Coryell Co.: LH 5760

Diospyros virginiana L., common persimmon. Native, perennial. Common along creek banks and other damp areas. Bell Co.: LH 4921, Coryell Co.: LH 6262

Elatinaceae

Bergia texana (Hook.) Seub. ex Walp., Texas bergia. Native, annual. Frequent in mud along margins of creeks and ponds. Bell Co.: **LH 5283**, Coryell Co.: **LS 4434**

Euphorbiaceae

Acalypha monococca (Engelm. ex A. Gray) Lill. W. Mill. & Gandhi, slender one-seeded mercury. Native, annual. Common on sandy Pleistocene terrace deposits. Bell Co.: **LS 765**, Coryell Co.: **LS 2883**

Acalypha ostryifolia Riddell, hop-hornbeam copperleaf. Native, annual. Occasional in disturbed areas. Coryell Co.: **LH 5190**

Acalypha phleoides Cav., Lindheimer's copperleaf. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LS 3260, Coryell Co.: LS 1709

Argythamnia humilis (Engelm. & A. Gray) Muell. Arg. var. *humilis*, low wild mercury. Native, perennial. Common in grasslands and disturbed areas. Bell Co.: **LS 2810**, Coryell Co.: **LS 1666**

Argythamnia mercurialina (Nutt.) Muell. Arg. var. *mercurialina*, tall wild mercury. Native, perennial. Occasional in grasslands. Bell Co.: KSRS 963, Coryell Co.: **LH 6795**

***Argythamnia simulans* J.W. Ingram**, Plateau silverbush. Native, perennial. Frequent in shaded woodlands. Bell Co.: LH 5186, Coryell Co.: **LH 5011**

Chamaesyce fendleri (Torr. & A. Gray) Small, creeping spurge. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LS 2487, Coryell Co.: LS 2073

Chamaesyce glyptosperma (Engelm.) Small, rib-seed sandmat. Native, annual. Rare in a post oak woodland. Coryell Co.: **LH 6242**

Chamaesyce maculata (L.) Small, spotted spurge. Native, annual. Frequent on roadside shoulders and in disturbed areas. Bell Co.: LH 5463, Coryell Co.: **LH 5301**

Chamaesyce missurica (Raf.) Shinners, prairie spurge. Native, annual. Common on dry limestone slopes and mesas. Bell Co.: LH 5288, Coryell Co.: **LS 2010**

Chamaesyce nutans (Lag.) Small, eyebane. Introduced, annual. Common in damp soil, especially in disturbed areas. Bell Co.: LS 2955, Coryell Co.: **LS 3568**

Chamaesyce prostrata (Aiton) Small, prostrate euphorbia. Native, annual. Common in disturbed areas. Bell Co.: LH 5128, Coryell Co.: **LS 3404**

Chamaesyce serpens (Kunth) Small, mat euphorbia. Native, annual. Common on mudflats, roadside shoulders, and disturbed areas. Bell Co.: LH 5104, Coryell Co.: **LS 4397**

Chamaesyce stictospora (Engelm.) Small, slim-seed sandmat. Native, annual. Rare along roadside shoulders and disturbed areas. Coryell Co.: **LH 5300**

Chamaesyce villifera (Scheele) Small, hairy spurge. Native, perennial. Common on dry limestone rimrock and adjacent slopes. Bell Co.: LS 2622, Coryell Co.: **LH 5065**

Cnidoscolus texanus (Muell. Arg.) Small, Texas bullnettle. Native, perennial. Common in disturbed grasslands, especially over sand. Bell Co.: LS 2785, Coryell Co.: LS 2463

***Croton alabamensis* E.A. Sm. ex Chapm. var. *texensis* Ginzbarg,** Texabama croton. Native, perennial. Occasional in mesic wooded canyons and adjacent limestone mesatops. Bell Co.: **LH 6448**, Coryell Co.: LH 5567

Croton capitatus Michx. var. *lindheimeri* (Engelm. & A. Gray) Muell. Arg., woolly croton. Native, annual. Frequent on sandy Pleistocene terrace deposits. Coryell Co.: **LS 2019**

Croton fruticulosus Engelm. ex Torr., encinilla. Native, perennial. Rare in mesic wooded canyons. Bell Co.: JS 4237

Croton glandulosus L. var. *lindheimeri* Muell. Arg., Lindheimer's croton. Native, annual. Occasional on sandy Pleistocene terrace deposits. Coryell Co.: **LH 6155**

Croton lindheimerianus Scheele, three-seed croton. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: SJC T33 (TEX)

Croton monanthogynus Michx., prairie-tea. Native, annual. Common in disturbed grasslands. Bell Co.: LS 2045, Coryell Co.: LS 2412

Croton texensis (Klotzsch) Muell. Arg., Texas croton. Native, annual. Common in sandy soil and disturbed areas. Bell Co.: LS 3576, Coryell Co.: LS 2020

Euphorbia bicolor Engelm. & A. Gray, snow-on-the-prairie. Native, annual. Common in disturbed grasslands. Bell Co.: LS 806, Coryell Co.: **LS 1999**

Euphorbia cyathophora Murray, wild poinsettia. Native, annual. Common in gravelly creekbeds and mesic wooded limestone canyons. Bell Co.: LS 1990, Coryell Co.: **LS 2884**

Euphorbia dentata Michx., toothed spurge. Native, annual. Common in disturbed areas. Bell Co.: LS 2042, Coryell Co.: **LS 4402**

Euphorbia longicruris Scheele, wedge-leaf euphorbia. Native, annual. Occasional in seasonally seeping limestone grasslands. Coryell Co.: LS 4378

Euphorbia marginata Pursh, snow-on-the-mountain. Native, annual. Common in disturbed grasslands. Bell Co.: LH 5279, Coryell Co.: LS 2000

Euphorbia spathulata Lam., warty euphorbia. Native, annual. Common in grasslands and open woodlands. Bell Co.: GG 373, Coryell Co.: **LH 4670**

Euphorbia tetrapora Engelm., weak spurge. Native, annual. Rare in open grassland. Coryell Co.: **LH 5667**

Phyllanthus abnormis Baill. var. *abnormis*, Drummond's leafflower. Native, annual. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LS 3378**

Phyllanthus polygonoides Nutt. ex Spreng., knotweed leafflower. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 1847, Coryell Co.: LS 2281

Stillingia texana I.M. Johnston, Texas stillingia. Native, perennial. Common in sandy soil and post oak woodlands. Bell Co.: LS 2486, Coryell Co.: LS 2427

Tragia betonicifolia Nutt., betony noseburn. Native, perennial. Frequent in sandy soil and open woodlands. Bell Co.: **LH 4938**, Coryell Co.: **LH 5543**

Tragia brevispica Engelm. & A. Gray, short-spike noseburn. Native, perennial. Common in riparian woodlands. Bell Co.: LS 4379, Coryell Co.: **WRC 17604**

Tragia ramosa Torr., catnip noseburn. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2220, Coryell Co.: LS 2289

Triadica sebifera (L.) Small, Chinese tallow tree. Introduced, perennial. Frequent along streams and other damp sites, cultivated, naturalized. Bell Co.: LH 6607, Coryell Co.: **LS 2911**

Fabaceae

Acacia angustissima (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob., fern acacia. Native, perennial. Frequent in grasslands. Bell Co.: LS 2848, Coryell Co.: LH 6533

Acacia farnesiana (L.) Willd., huisache. Native, perennial. Occasional near old homesites, possibly cultivated, naturalized. Bell Co.: LH 4911, Coryell Co.: **LH 6312**

Albizia julibrissin Durazz., mimosa tree. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LS 2521**, Coryell Co.: **LS 2595**

Amorpha fruticosa L., false indigo. Native, perennial. Common along banks of creeks. Bell Co.: LS 1995, Coryell Co.: LS 3973

Astragalus lotiflorus Hook., lotus milk-vetch. Native, perennial. Occasional on dry rocky limestone. Bell Co.: LH 6342, Coryell Co.: **LH 6343**

Astragalus nuttallianus DC. var. *austrinus* (Small) Barneby, small-flowered milk-vetch. Native, annual. Rare in grasslands and disturbed areas. Bell Co.: **LH 6333**

Astragalus nuttallianus DC. var. *nuttallianus*, Nuttall's milk-vetch. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 1677, Coryell Co.: LS 2260

Astragalus nuttallianus DC. var. *trichocarpus* Torr. & A. Gray, southwestern milk-vetch. Native, annual. Rare in grasslands and disturbed areas. Coryell Co.: **LH 4667**

***Astragalus reflexus* Torr. & A. Gray,** Texas milk-vetch. Native, annual. Occasional in grasslands, especially near riparian corridors. Bell Co.: LH 6479, Coryell Co.: **LH 5679**

***Astragalus wrightii* A. Gray,** Wright's milk-vetch. Native, annual. Rare in grasslands on dry rocky limestone. Bell Co.: LH 6416, Coryell Co.: **LH 6406**

Caesalpinia gilliesii (Wallich ex Hook.) Wallich ex D. Dietr., bird-of-paradise. Introduced, perennial. Rare at an old homesite, cultivated, not persisting. Bell Co.: **LS 1490**

Centrosema virginianum (L.) Benth., spurred butterfly pea. Native, perennial. Rare on sandy Pleistocene terrace deposits. Bell Co.: CLGY 55301 (HABAYC)

Cercis canadensis L. var. *texensis* (S. Watson) M. Hopkins, Texas redbud. Native, perennial. Common on limestone slopes, canyons, and mesas. Bell Co.: GG 350, Coryell Co.: LS 2126

Chamaecrista fasciculata (Michx.) Greene var. *fasciculata*, partridge-pea. Native, annual. Common in disturbed grasslands. Bell Co.: LS 2996, Coryell Co.: LS 4492

Clitoria mariana L., Atlantic pigeon-wings. Native, perennial. Rare on sandy soils and post oak woodlands. Coryell Co.: **LH 5950**

Dalea aurea Nutt. ex Pursh, golden dalea. Native, perennial. Common in grasslands. Bell Co.: LS 2834, Coryell Co.: LS 2896

Dalea compacta Spreng. var. *pubescens* (A. Gray) Barneby, compact prairie-clover. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 2730, Coryell Co.: LH 6544

Dalea enneandra Nutt., big-top dalea. Native, perennial. Rare in grasslands. Bell Co.: JC s.n.

Dalea frutescens A. Gray, black dalea. Native, perennial. Common in open woodlands of rocky limestone slopes and mesatops. Bell Co.: LS 2971, Coryell Co.: LS 3432

***Dalea hallii* A. Gray,** Hall's prairie-clover. Native, perennial. Frequent on dry rocky limestone. Bell Co.: **LS 4249**, Coryell Co.: **LH 5303**

Dalea multiflora (Nutt.) Shinners, round-head dalea. Native, perennial. Common in grasslands over dry rocky limestone. Bell Co.: LH 6060, Coryell Co.: LS 4431

Dalea nana Torr. ex A. Gray var. *nana*, dwarf prairie-clover. Native, perennial. Rare in sandy soil. Coryell Co.: **LH 6535**

***Dalea tenuis* (J.M. Coult.) Shinners**, Stanfield prairie-clover. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LH 6024, Coryell Co.: LS 2864

Desmanthus acuminatus Benth., sharp-pod bundle-flower. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 3253, Coryell Co.: **LS 2754**

Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald, Illinois bundle-flower. Native, perennial. Common in grasslands and damp areas. Bell Co.: LS 2918, Coryell Co.: LS 2598

Desmanthus leptolobus Torr. & A. Gray, prairie bundle-flower. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LH 4962, Coryell Co.: LS 2573

Desmanthus velutinus Scheele, velvet bundle-flower. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 2807, Coryell Co.: LS 1887

Desmodium glabellum (Michx.) DC., Dillenius' tick-trefoil. Native, perennial. Rare in mesic canyons. Bell Co.: **LH 6107**, Coryell Co.: **LH 6247**

Desmodium paniculatum (L.) DC., panicled tick-clover. Native, perennial. Common along banks of creeks and in other damp areas. Bell Co.: LS 2057, Coryell Co.: **LH 5324**

Desmodium psilophyllum Schlecht., Wright's tick-clover. Native, perennial. Common in mesic limestone canyons and slopes. Bell Co.: **LS 1838**, Coryell Co.: **LH 5480**

Desmodium tweedyi Britton, Tweedy's tick-clover. Native, perennial. Common along banks of creeks and in other damp areas. Bell Co.: **LH 5187**, Coryell Co.: **LS 3293**

Eysenhardtia texana Scheele, Texas kidneywood. Native, perennial. Frequent in woodlands on dry limestone slopes and mesas. Bell Co.: LS 2022, Coryell Co.: LS 2966

Galactia volubilis (L.) Britton, downy milk-pea. Native, perennial. Frequent in mesic woodlands. Bell Co.: **LH 5046**, Coryell Co.: **LS 3899**

Gleditsia triacanthos L., common honey-locust. Native, perennial. Common in woodlands, especially near old homesites. Bell Co.: **LH 5127**, Coryell Co.: LH 5477

Indigofera miniata Ortega, scarlet-pea. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 1774, Coryell Co.: LS 2666

Lathyrus hirsutus L., rough-pea. Introduced, annual. Occasional in grasslands. Coryell Co.: **LS 2266**

Lathyrus pusillus Elliot, low peavine. Native, annual. Occasional in grasslands and open woodlands. Bell Co.: LH 6409, Coryell Co.: **LS 1664**

Lespedeza procumbens Michx., trailing bush-clover. Native, perennial. Common on wooded limestone slopes and mesatops. Bell Co.: LS 2620, Coryell Co.: **LS 2880**

Lespedeza repens (L.) W. Bart., creeping bush-clover. Native, perennial. Frequent in sandy soils and post oak woodlands. Bell Co.: **LH 5526**, Coryell Co.: **CC 1277**

Lespedeza texana Britton, Texas bush-clover. Native, perennial. Common on wooded limestone slopes and mesatops. Bell Co.: LH 5395, Coryell Co.: **LS 2813**

Lespedeza virginica (L.) Britton, slender bush-clover. Native, perennial. Common in sandy soils and post oak woodlands. Bell Co.: LH 5396, Coryell Co.: **LH 5287**

Lotus unifoliolatus (Hook.) Benth. var. *helleri* (Britton) Kartesz & Gandhi, Pursh's deer-vetch. Native, annual. Common in sandy soils and post oak woodlands. Bell Co.: LS 2575, Coryell Co.: **LS 2564**

Lupinus texensis Hook., Texas bluebonnet. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LH 6411, Coryell Co.: LS 2676

Medicago arabica (L.) Huds., spotted medick. Introduced, annual. Rare in disturbed alluvial floodplain. Coryell Co.: **LH 5593**

Medicago lupulina L., black medick. Introduced, annual. Common in grasslands, disturbed areas, and along roadside shoulders. Bell Co.: LS 1864, Coryell Co.: **LS 2544**

Medicago minima (L.) L., small bur-clover. Introduced, annual. Common in grasslands, disturbed areas, and along roadside shoulders. Bell Co.: LS 1863, Coryell Co.: LS 2229

Medicago orbicularis (L.) Bartal., button clover. Introduced, annual. Frequent in grasslands, disturbed areas, and along roadside shoulders. Bell Co.: LS 3252, Coryell Co.: **LS 2438**

Medicago polymorpha L., California button clover. Introduced, annual. Frequent in grasslands and disturbed areas. Bell Co.: LH 5617, Coryell Co.: LH 5624

Medicago sativa L., alfalfa. Introduced, perennial. Rare on roadside shoulder, seeded area, cultivated, persisting. Bell Co.: LH 4942

Melilotus indicus (L.) All., sour-clover. Introduced, annual. Frequent in grasslands and disturbed areas. Bell Co.: LS 2315, Coryell Co.: **LH 4943**

Melilotus officinalis (L.) Lam., yellow sweet-clover. Introduced, biennial or perennial. Frequent in grasslands, disturbed areas, and along roadside shoulders. Bell Co.: LH 5057, Coryell Co.: LH 5839

Mimosa aculeaticarpa Ortega var. *biuncifera* (Benth.) Barneby, catclaw. Native, perennial. Common in post oak woodlands. Bell Co.: LS 3561, Coryell Co.: LS 1465

Mimosa borealis A. Gray, fragrant mimosa. Native, perennial. Common on dry limestone slopes and mesas. Bell Co.: LH 6412, Coryell Co.: **LS 2290**

Mimosa roemeriana Scheele, Roemer's sensitive-briar. Native, perennial. Common on sandy soils and post oak woodlands. Bell Co.: LS 3263, Coryell Co.: LS 2419

Neptunia lutea (Leavenworth) Benth., yellow-puff. Native, perennial. Common in grasslands and disturbed areas. Bell Co.: LS 1486, Coryell Co.: LS 3565

Parkinsonia aculeata L., retama. Native, perennial. Occasional near old homesites, cultivated, naturalized. Bell Co.: LH 5884, Coryell Co.: LH 6569

Pediomelum cuspidatum (Pursh) Rydb., tall-bread scurf-pea. Native, perennial. Occasional on rocky limestone slopes and mesas. Bell Co.: **LH 6615**, Coryell Co.: LH 5876

***Pediomelum cyphocalyx* (A. Gray) Rydb.**, turnip-root scurf-pea. Native, perennial. Occasional in grasslands on dry rocky limestone. Bell Co.: LH 6616, Coryell Co.: LH 6027

***Pediomelum hypogaeum* (Nutt. ex Torr. & A. Gray) Rydb. var. *scaposum* (A. Gray) Mahler**, stemless scurf-pea. Native, perennial. Rare in grasslands on dry rocky limestone. Bell Co.: LS 2200, Coryell Co.: **LH 6546**

***Pediomelum latestipulatum* (Shiners) Mahler var. *appressum* (D.J. Ockendon) Gandhi & L.E. Brown**, Texas Plains Indian breadroot. Native, perennial. Rare in grasslands on dry rocky limestone. Bell Co.: **LS 2212**

Pediomelum linearifolium (Torr. & A. Gray) J. Grimes, narrow-leaf scurf-pea. Native, perennial. Frequent in grasslands on dry rocky limestone. Bell Co.: LH 6617, Coryell Co.: LH 5889

Pediomelum rhombifolium (Torr. & A. Gray) Rydb., round-leaf scurf-pea. Native, perennial. Occasional in sandy soils and post oak woodlands. Coryell Co.: **LS 1816**

Prosopis glandulosa Torr., honey mesquite. Native, perennial. Common in grasslands and open woodlands, especially in deeper soils. Bell Co.: LS 1792, Coryell Co.: LS 2616

Psoralidium tenuiflorum (Pursh) Rydb., slim-leaf scurf-pea. Native, perennial. Occasional in open woodlands. Bell Co.: LH 5147, Coryell Co.: LS 3900

Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & S. Almeida, kudzu. Introduced, perennial. Rare along disturbed roadside, climbing onto shrubs and trees. Bell Co.: **LS 1559**

Rhynchosia senna Gillies ex Hook. var. *texana* (Torr. & A. Gray) M.C. Johnst., snout-bean. Native, perennial. Common in open woodlands and disturbed areas. Bell Co.: LS 3897, Coryell Co.: **LS 1882**

Securigera varia (L.) Lassen, crown-vetch. Introduced, perennial. Rare in disturbed areas. Bell Co.: **LS 3299**

Senna marilandica (L.) Link, wild senna. Native, perennial. Occasional in open woodlands and disturbed areas. Bell Co.: LS 2950, Coryell Co.: **LH 6674**

Senna roemeriana (Scheele) Irwin & Barneby, two-leaf senna. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LH 6419, Coryell Co.: LS 2443

Sesbania herbacea (Mill.) McVaugh, coffee-bean. Native, annual. Frequent in damp mud along ponds and lakes. Bell Co.: **LH 5479**, Coryell Co.: **LS 4486**

Sesbania vesicaria (Jacq.) Elliot, bladder pod. Native, annual. Common in damp soil of creek banks and roadside ditches. Bell Co.: **LH 5278**, Coryell Co.: **LH 5277**

Sophora secundiflora (Ortega) Lag. ex DC., Texas mountain laurel. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LS 2135, Coryell Co.: LS 2401

Strophostyles helvola (L.) Elliott, amberique bean. Native, annual. Frequent in sandy soil and post oak woodlands. Bell Co.: LS 2061, Coryell Co.: **LS 3428**

Strophostyles leiosperma (Torr. & A. Gray) Piper, slickseed fuzzy-bean. Native, annual. Rare in sandy soil and post oak woodlands. Bell Co.: CLGY 55137 (HABAYC)

Stylosanthes biflora (L.) Britton, Sterns, & Poggenb., side-beak pencil-flower. Native, perennial. Rare in sandy alluvium. Coryell Co.: **WRC 17591**

Styphnolobium affine (Torr. & A. Gray) Walp., Eve's necklace. Native, perennial. Frequent in most woodlands. Bell Co.: **GG 372**, Coryell Co.: **LS 1890**

Trifolium repens L., white clover. Introduced, perennial. Rare in disturbed areas, along creek banks, and in lawns. Bell Co.: **LH 6073**, Coryell Co.: **LS 3288**

Vicia ludoviciana Nutt., deer pea vetch. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2322, Coryell Co.: LS 2249

Vicia sativa L. ssp. *nigra* (L.) Ehrh., common vetch. Introduced, annual. Frequent in disturbed grasslands and roadsides. Bell Co.: **LH 5618**, Coryell Co.: **LH 4661**

Vicia villosa Roth ssp. *varia* (Host) Corb., winter vetch. Introduced, annual. Rare in grasslands and disturbed areas. Coryell Co.: **VM s.n.**

Fagaceae

Quercus buckleyi Nixon & Dorr, Buckley's oak. Native, perennial. Common on dry limestone slopes, canyons, and mesas. Bell Co.: LS 2133, Coryell Co.: LS 2127

Quercus fusiformis Small, Plateau live oak. Native, perennial. Common in most habitats. Bell Co.: LS 2205, Coryell Co.: LS 2636

Quercus macrocarpa Michx., bur oak. Native, perennial. Common along riparian corridors. Bell Co.: LS 1697, Coryell Co.: **LH 4749**

Quercus marilandica Muenchh., blackjack oak. Native, perennial. Common on sandy soils and post oak woodlands. Bell Co.: LS 4630, Coryell Co.: LH 4665

Quercus muehlenbergii Engelm., chinkapin oak. Native, perennial. Common in mesic wooded canyons and slopes. Bell Co.: LS 1994, Coryell Co.: **LS 4635**

Quercus shumardii Buckley, Shumard red oak. Native, perennial. Common along riparian corridors. Bell Co.: LH 5643, Coryell Co.: **LH 6304**

Quercus sinuata Walter var. *breviloba* (Torr.) C.H. Mull., Bigelow's oak. Native, perennial. Common on limestone mesatops and in mesic wooded canyons. Bell Co.: LS 2114, Coryell Co.: **LS 2284**

Quercus stellata Wangenh., post oak. Native, perennial. Common on sandy soils and post oak woodlands. Bell Co.: LS 2321, Coryell Co.: **LS 2274**

Fumariaceae

Corydalis micrantha (Engelm. ex A. Gray) A. Gray ssp. *australis* (Chapm.) G.B. Ownbey, southern corydalis. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: CLGY 54023 (TEX), Coryell Co.: **LH 5596**

Corydalis micrantha (Engelm. ex A. Gray) A. Gray ssp. *micrantha*, small-flower corydalis. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: **LH 5586**

Garryaceae

Garrya ovata Benth. ssp. *lindheimeri* (Torr.) Dahling, Lindheimer's silktassel. Native, perennial. Rare in a mesic wooded canyon. Bell Co.: **LS 2324**

Gentianaceae

Centaurium beyrichii (Torr. & A. Gray ex Torr.) B.L. Rob., mountain-pink. Native, annual. Common on dry rocky limestone. Bell Co.: LS 4390, Coryell Co.: LH 5051

Centaurium muehlenbergii (Griseb.) W. Wright ex Piper, Muhlenberg's centaury. Introduced, annual. Frequent in seasonally seeping limestone soil. Bell Co.: **LS 3301**, Coryell Co.: **LH 6614**

Centaurium texense (Griseb.) Fernald, Texas centaury. Native, annual. Common in grasslands on dry rocky limestone. Bell Co.: LS 2488, Coryell Co.: LS 2538

Eustoma exaltatum (L.) Salisb. ex G. Don ssp. *russellianum* (Hook.) Kartesz, bluebell gentian. Native, annual or perennial. Common in seasonally seeping limestone soil and along creek banks, especially in sun. Bell Co.: **LS 4590**, Coryell Co.: LS 3567

Sabatia campestris Nutt., prairie rose gentian. Native, annual. Occasional on sandy soils and post oak woodlands. Bell Co.: CLGY 54441 (HABAYC), Coryell Co.: LS 3370

Geraniaceae

Erodium cicutarium (L.) L'Her. ex Aiton, filaree. Introduced, annual. Common in grasslands and disturbed areas. Bell Co.: LS 1701, Coryell Co.: **LS 2225**

Erodium texanum A. Gray, Texas stork's-bill. Native, annual. Common in grasslands and disturbed areas. Bell Co.: GG 347, Coryell Co.: LS 2226

Geranium carolinianum L., crane's-bill. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 1703, Coryell Co.: **LS 2231**

Geranium texanum (Trel.) A. Heller, Texas geranium. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 1836, Coryell Co.: LS 2643

Haloragaceae

Myriophyllum heterophyllum Michx., two-leaf water-milfoil. Native, perennial. Occasional in ponds and lakes, submersed. Bell Co.: LH 5265, Coryell Co.: LH 5484

Hippocastanaceae

Aesculus glabra Willd. var. *arguta* (Buckley) B.L. Rob., Texas buckeye. Native, perennial. Frequent along riparian corridors and in mesic wooded canyons. Bell Co.: LS 4638, Coryell Co.: **LS 4625**

Hydrophyllaceae

Nama hispidum A. Gray, sandbells. Native, annual. Rare on sandy Pleistocene terrace deposits and post oak woodlands. Bell Co.: CLGY 54438 (HABAYC), Coryell Co.: LH 6541

Nama jamaicense L., Jamaican weed. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: LH 5687, Coryell Co.: **LH 5752**

Nemophila phacelioides Nutt., baby blue-eyes. Native, annual. Common in shade along riparian corridors. Bell Co.: LH 5620, Coryell Co.: **LH 5755**

Phacelia congesta Hook., blue-curls. Native, annual. Common in open woodlands over limestone slopes. Bell Co.: LH 4970, Coryell Co.: **LS 1711**

Juglandaceae

Carya illinoinensis (Wangenh.) K. Koch, pecan. Native, perennial. Common along riparian corridors. Bell Co.: LS 1844, Coryell Co.: LS 3292

Juglans major (Torr.) A. Heller, Arizona walnut. Native, perennial. Common in mesic wooded canyons and riparian corridors. Bell Co.: LS 1843, Coryell Co.: LS 2254

Juglans microcarpa Berl., Texas walnut. Native, perennial. Rare along gravelly creek bed. Coryell Co.: **LS 1717**

Juglans nigra L., black walnut. Native, perennial. Common along riparian corridors. Bell Co.: CC 1462, Coryell Co.: **LS 2832**

Krameriaceae

Krameria lanceolata Torr., trailing ratany. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 1851, Coryell Co.: LS 2423

Lamiaceae

Clinopodium arkansanum (Nutt.) House, limestone calamint. Native, perennial. Rare in seasonally seeping limestone soil. Bell Co.: LH 5924

Hedeoma acinoides Scheele, annual pennyroyal. Native, annual. Common in grasslands and open woodlands. Bell Co.: LH 6410, Coryell Co.: **LS 2283**

Hedeoma drummondii Benth., Drummond's hedeoma. Native, perennial. Common in grasslands and open woodlands. Bell Co.: **LS 2621**, Coryell Co.: **LS 2898**

Hedeoma reverchonii (A. Gray) A. Gray var. *reverchonii*, rock hedeoma. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2682, Coryell Co.: LS 3978

Hedeoma reverchonii (A. Gray) A. Gray var. *serpyllifolia* (Small) Irving, Reverchon's false pennyroyal. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: **LH 4941**, Coryell Co.: **LH 5000**

Lamium amplexicaule L., henbit. Introduced, annual. Occasional in disturbed areas, lawns, and near old homesites. Bell Co.: LS 4637, Coryell Co.: **LS 4600**

Lycopus americanus Muhl. ex W. Bart., American bugleweed. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LS 2064, Coryell Co.: LH 5109

Marrubium vulgare L., common horehound. Introduced, perennial. Frequent in grasslands and disturbed areas, especially near old homesites. Bell Co.: LS 1791, Coryell Co.: **LS 2657**

Mentha x *piperita* L. (pro sp.) [*aquatica* x *spicata*], peppermint. Introduced, perennial. Rare along banks of creeks and other damp areas. Bell Co.: LS 1972

Mentha spicata L., spearmint. Introduced, perennial. Rare along banks of creeks and other damp areas. Bell Co.: CLGY 54545 (HABAYC)

Monarda citriodora Cerv. ex Lag., lemon beebalm. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2808, Coryell Co.: **LS 2439**

***Monarda punctata* L. ssp. *punctata* var. *intermedia* (E.M. McClint. & Epling) Waterf.**, spotted beebalm. Native, annual. Occasional on sandy Pleistocene terrace deposits. Bell Co.: **CLGY 54256** (TEX), Coryell Co.: **LH 5958**

Salvia azurea Michx. ex Lam. var. *grandiflora* Benth., giant blue sage. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 3430, Coryell Co.: **LS 4498**

***Salvia engelmannii* A. Gray,** Engelmann's sage. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LH 5764, Coryell Co.: LH 6348

Salvia farinacea Benth., mealy sage. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LH 4935, Coryell Co.: **LS 2668**

Salvia reflexa Hornem., lance-leaf sage. Native, annual. Rare in grasslands and disturbed areas. Bell Co.: LH 6287

Salvia roemeriana Scheele, cedar sage. Native, perennial. Common in mesic wooded canyons and hillsides. Bell Co.: GG 358, Coryell Co.: **LH 5612**

Salvia texana (Scheele) Torr., Texas sage. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: GG 348, Coryell Co.: **LS 2293**

Scutellaria drummondii Benth. var. *drummondii*, Drummond's skullcap. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2342, Coryell Co.: LS 1712

Scutellaria ovata Hill ssp. *bracteata* (Benth.) Elping, egg-leaf skullcap. Native, perennial. Frequent in mesic limestone wooded canyons. Bell Co.: LS 2842, Coryell Co.: **LH 5009**

Scutellaria wrightii A. Gray, Wright's skullcap. Native, perennial. Common on dry rocky limestone. Bell Co.: LH 5765, Coryell Co.: **LS 2300**

Stachys crenata Raf., shade betony. Native, annual or perennial. Frequent in shade along riparian corridors. Bell Co.: LH 5587, Coryell Co.: **LS 2649**

Teucrium canadense L., American germander. Native, perennial. Common in shade of upland woodlands and riparian corridors. Bell Co.: LS 4380, Coryell Co.: LS 4400

Teucrium laciniatum Torr., cut-leaf germander. Native, perennial. Rare in grasslands on rocky limestone. Coryell Co.: LH 5873

Trichostema brachiatum L., flux-weed. Native, annual. Frequent in disturbed areas. Bell Co.: LH 5189, Coryell Co.: LS 1414

Warnockia scutellarioides (Engelm. & A. Gray) M.W. Turner, prairie brazoria. Native, annual. Common in grasslands on rocky limestone. Bell Co.: LS 2722, Coryell Co.: LS 2411

Lauraceae

Lindera benzoin (L.) Blume var. *pubescens* (Palmer & Steyerm.) Rehder, northern spicebush. Native, perennial. Frequent in mesic wooded canyons, especially near springs. Bell Co.: LH 5576, Coryell Co.: **LH 5568**

Lentibulariaceae

Utricularia gibba L., cone-spur bladderwort. Native, perennial. Occasional in ponds and lakes, submersed. Bell Co.: LS 2942

Linaceae

Linum berlandieri Hook. var. *berlandieri*, Berlandier's flax. Native, annual. Common in grasslands. Bell Co.: LS 2333, Coryell Co.: LS 2446

Linum grandiflorum Desf., flowering flax. Introduced, annual.

Rare on roadside shoulders and seeded areas, cultivated, not persisting. Coryell Co.: KSNH 787 (CMML)

Linum hudsonioides Planch., Texas flax. Native, annual. Rare in sandy soil and post oak woodlands. Bell Co.: LH 6801, Coryell Co.: **LH 5671**

Linum rupestre (A. Gray) Engelm. ex A. Gray, rock flax. Native, annual. Common on dry open limestone slopes and mesas. Bell Co.: LS 2660, Coryell Co.: LS 2406

Loasaceae

Mentzelia oligosperma Nutt. ex Sims, stick-leaf. Native, perennial. Frequent on dry limestone slopes and mesas. Bell Co.: LH 5904, Coryell Co.: LS 2745a

Loganiaceae

Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray, lax hornpod. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5268, Coryell Co.: **LH 5165**

Spigelia hedyotidea A. DC., prairie pinkroot. Native, perennial. Rare in shade of woodlands. Bell Co.: **LH 5903,** Coryell Co.: **LH 6563**

Lythraceae

Ammannia coccinea Rottb., purple ammannia. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5180, Coryell Co.: **LS 4439**

Lagerstroemia indica L., common crape-myrtle. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LH 6048**, Coryell Co.: **LS 2914**

Lythrum californicum Torr. & A. Gray, California loosestrife. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LS 2843, Coryell Co.: LS 2710

Malvaceae

Abutilon fruticosum Guill. & Perr., Indian-mallow. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2929, Coryell Co.: **LS 2522**

Callirhoe involucrata (Torr. & A. Gray) A. Gray var. *involucrata*, low poppy-mallow. Native, perennial. Frequent on sandy soils and post oak woodlands. Bell Co.: CLGY 55111 (HABAYC), Coryell Co.: LH 6536

Callirhoe pedata (Nutt. ex Hook.) A. Gray, finger poppy-mallow. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 3274, Coryell Co.: LS 2435

Malva neglecta Wallr., common mallow. Introduced, annual or biennial. Occasional in disturbed areas and near old homesites. Bell Co.: **LS 2781**

***Malvastrum aurantiacum* (Scheele) Walp.**, golden false-mallow. Native, perennial. Occasional on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 5451**

Malvaviscus arboreus Dill. ex Cav. var. *drummondii* (Torr. & A. Gray) Schery, Drummond wax-mallow. Native, perennial. Occasional in mesic wooded canyons and along riparian corridors. Bell Co.: **LS 2626**, Coryell Co.: **LH 6675**

Modiola caroliniana (L.) G. Don, Carolina modiola. Native, perennial. Occasional in disturbed areas and in lawns. Bell Co.: **LH 5837**, Coryell Co.: **LS 2639**

Rhynchosida physocalyx (A. Gray) Fryxell, spear-leaf sida. Native, perennial. Common in open woodlands, especially in partial shade. Bell Co.: **LS 2933**, Coryell Co.: LH 6539

Sida abutifolia Mill., spreading sida. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LH 4959, Coryell Co.: **LS 2702**

Sida spinosa L., prickly fanpetals. Native, annual. Occasional in damp soil, disturbed areas. Bell Co.: LH 6105

Meliaceae

Melia azedarach L., China-berry. Introduced, perennial. Common in most habitats, cultivated, naturalized. Bell Co.: LS 2680, Coryell Co.: **LS 2267**

Menispermaceae

Cocculus carolinus (L.) DC., Carolina snailseed. Native, perennial. Common in most woodlands, climbing onto shrubs. Bell Co.: LS 2861, Coryell Co.: **LS 3414**

Molluginaceae

Mollugo verticillata L., green carpetweed. Native, annual. Rare on sandy Pleistocene terrace deposits. Bell Co.: CLGY 55142 (HABAYC), Coryell Co.: **LH 6157**

Moraceae

Ficus carica L., common fig. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LS 1964**, Coryell Co.: **LH 6639**

Maclura pomifera (Raf.) C.K. Schneid., Osage orange. Native, perennial. Common along riparian corridors and fencerows. Bell Co.: LS 2679, Coryell Co.: LS 1907

Morus alba L., white mulberry. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: LS 1699, Coryell Co.: **LH 5296**

Morus microphylla Buckley, Texas mulberry. Native, perennial. Common in mesic wooded canyons. Bell Co.: JS 4225, Coryell Co.: **LH 4907**

Morus rubra L., red mulberry. Native, perennial. Common along riparian corridors and in mesic wooded canyons. Bell Co.: LS 1696, Coryell Co.: LS 2758

Nyctaginaceae

Boerhavia diffusa L., scarlet spiderling. Native, perennial. Occasional in sandy soil and disturbed areas. Bell Co.: LH 6670, Coryell Co.: **LH 5455**

Mirabilis albida (Walter) Heimerl, white four-o'clock. Native, perennial. Common in open woodlands. Bell Co.: LH 5175, Coryell Co.: **LH 5472**

Mirabilis jalapa L., marvel of Peru. Introduced, perennial. Occasional at old homesites, cultivated, naturalized. Coryell Co.: **LH 6061**

Mirabilis latifolia (A. Gray) Diggs, Lipscomb, & O'Kennon, broad-leaved four-o'clock. Native, perennial. Common in open woodlands. Bell Co.: **LS 2983**, Coryell Co.: **LH 5600**

Mirabilis linearis (Pursh) Heimerl, linear-leaf four-o'clock. Native, perennial. Occasional in grasslands and open woodlands. Bell Co.: **LH 5039**, Coryell Co.: **LH 4912**

Mirabilis nyctaginea (Michx.) MacMill., wild four-o'clock. Native, perennial. Occasional in open woodlands and mesatops. Bell Co.: **LH 5048**, Coryell Co.: **LS 4243**

Oleaceae

Forestiera pubescens Nutt. var. *glabrifolia* Shinners, smooth-leaf forestiera. Native, perennial. Common in most woodlands. Bell Co.: LS 2320, Coryell Co.: **LS 2285**

Forestiera pubescens Nutt. var. *pubescens*, elbow-bush. Native, perennial. Common in most woodlands. Bell Co.: LS 2130, Coryell Co.: **LS 2121**

Fraxinus americana L., white ash. Native, perennial. Common along riparian corridors. Bell Co.: **LH 5053**, Coryell Co.: **LS 2549**

Fraxinus pennsylvanica Marsh., green ash. Native, perennial. Common along riparian corridors. Coryell Co.: **LH 5075**

Fraxinus texensis (A. Gray) Sarg., Texas white ash. Native, perennial. Common in woodlands. Bell Co.: GG 354, Coryell Co.: LS 4614

Fraxinus velutina Torr., velvet ash. Native, perennial. Frequent along streams and other damp sites, cultivated, naturalized. Bell Co.: **LH 5380**, Coryell Co.: **LH 5378**

Jasminum nudiflorum Lindl., winter jasmine. Introduced, perennial. Rare at one old homesite, cultivated, persisting. Coryell Co.: **LH 6306**

Ligustrum lucidum W.T. Aiton, glossy privet. Introduced, perennial. Common along streams and other damp sites, cultivated, naturalized. Bell Co.: **LS 4596**, Coryell Co.: **LS 2596**

Ligustrum sinense Lour., Chinese privet. Introduced, perennial. Frequent along streams and other damp sites, cultivated, naturalized. Bell Co.: **LH 6800**, Coryell Co.: **LH 5874**

Syringa x *persica* L. [*afghanica* x *laciniata*], Persian lilac. Introduced, perennial. Rare at one old homesite, cultivated, persisting. Bell Co.: **LS 4632**

Onagraceae

Calylophus berlandieri Spach ssp. *berlandieri*, half-shrub sundrops. Native, perennial. Common in grasslands and open woodlands. Bell Co.: **LS 2694**, Coryell Co.: **LS 2708**

Calylophus berlandieri Spach ssp. *pinifolius* (Engelm. & A. Gray) Towner, Berlandier's evening-primrose. Native, perennial. Common in grasslands and open woodlands. Bell Co.: **GG 346**, Coryell Co.: LS 2899

Gaura brachycarpa Small, plains gaura. Native, annual. Frequent in grasslands and open woodlands. Bell Co.: LS 2341, Coryell Co.: **LS 2568**

Gaura coccinea Nutt. ex Pursh, scarlet gaura. Native, perennial. Common in open woodlands. Bell Co.: LS 1674, Coryell Co.: **LS 1719**

Gaura drummondii (Spach) Torr. & A. Gray, sweet gaura. Native, perennial. Frequent in post woodlands and sandy soils. Bell Co.: LH 5859, Coryell Co.: **LS 2404**

Gaura longiflora Spach, tall gaura. Native, annual or biennial. Rare in grasslands and open woodlands. Coryell Co.: **CC 1488**

Gaura mollis James, lizard-tail gaura. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 3258, Coryell Co.: **LS 3975**

Gaura sinuata Nutt. ex Ser., wavy-leaf gaura. Native, perennial. Common in grasslands and disturbed areas. Bell Co.: LS 2495, Coryell Co.: LS 2526

Gaura suffulta Engelm. ex A. Gray ssp. *suffulta*, roadside gaura. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2379, Coryell Co.: LS 2527

Ludwigia octovalvis (Jacq.) P.H. Raven, shrubby water-primrose. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5193, Coryell Co.: **LH 5308**

Ludwigia palustris (L.) Elliot, marsh-purslane. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2502, Coryell Co.: LS 3966

Ludwigia peploides (Kunth) P.H. Raven, floating primrose-willow. Native, perennial. Occasional along banks of creeks and other damp areas. Bell Co.: LH 6669

Ludwigia repens J.R. Forst., creeping water-primrose. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 4287, Coryell Co.: **LH 5305**

Oenothera jamesii Torr. & A. Gray, river primrose. Native, biennial. Frequent along banks of creeks and other damp areas. Bell Co.: LS 3961, Coryell Co.: LH 5392

Oenothera laciniata Hill, cut-leaf evening-primrose. Native, annual or perennial. Frequent on sandy Pleistocene terrace deposits. Bell Co.: LH 5684, Coryell Co.: **LH 4672**

Oenothera macrocarpa Nutt. ssp. *macrocarpa*, flutter-mill. Native, perennial. Common on dry rocky limestone. Bell Co.: LS 2485, Coryell Co.: LS 2528

Oenothera rhombipetala Nutt. ex Torr. & A. Gray, four-point evening-primrose. Native, biennial. Rare on sandy Pleistocene terrace deposits. Coryell Co.: LH 6612

Oenothera speciosa Nutt., showy primrose. Native, perennial. Common in grasslands, open woodlands, and disturbed areas. Bell Co.: LS 2386, Coryell Co.: LS 2255

Oenothera triloba Nutt., stemless evening-primrose. Native, annual. Frequent on limestone mesatops and dry grasslands. Bell Co.: LS 4649, Coryell Co.: **LS 1444**

Stenosiphon linifolius (Nutt. ex E. James) Heynh., false gaura. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 2629, Coryell Co.: LS 4429

Oxalidaceae

Oxalis corniculata L., creeping ladies'-sorrel. Introduced, perennial. Frequent in most habitats. Bell Co.: LH 5645, Coryell Co.: LH 5640

Oxalis dillenii Jacq., slender yellow wood-sorrel. Native, perennial. Frequent in most habitats. Bell Co.: LH 5857, Coryell Co.: LH 5960

Oxalis drummondii A. Gray, purple wood-sorrel. Native, perennial. Occasional in grasslands and open woodlands. Bell Co.: LH 5536, Coryell Co.: LH 6252

Papaveraceae

Argemone albiflora Hornem. ssp. *texana* G.B. Ownbey, white prickly-poppy. Native, annual or biennial. Common in disturbed grasslands. Bell Co.: **LS 2840**, Coryell Co.: **LS 3286**

***Argemone aurantiaca* G.B. Ownbey,** Texas prickly-poppy. Native, annual or biennial. Rare in disturbed grasslands. Bell Co.: LH 6632, Coryell Co.: **LH 6814**

Passifloraceae

***Passiflora affinis* Engelm.,** bracted passion-flower. Native, perennial. Common in mesic woodlands, climbing onto shrubs and trees. Bell Co.: LH 5114, Coryell Co.: **LH 5257**

Passiflora lutea L., yellow passion-flower. Native, perennial. Common in mesic woodlands, climbing onto shrubs and trees. Bell Co.: LH 5003, Coryell Co.: **LH 5050**

Passiflora tenuiloba Engelm., bird-wing passion-flower. Native, perennial. Rare on limestone cliffs of mesic wooded canyons. Bell Co.: **LH 5539**

Pedaliaceae

Proboscidea louisianica (Mill.) Thell., common devil's claw. Native, annual. Common in disturbed areas. Bell Co.: LS 2855, Coryell Co.: **LS 2614**

Phytolaccaceae

Phytolacca americana L., American pokeweed. Native, annual. Common in open woodlands and disturbed areas. Bell Co.: LS 2625, Coryell Co.: LS 3310

Rivina humilis L., pigeon-berry. Native, perennial. Frequent in shade of woodlands. Bell Co.: LS 2934, Coryell Co.: LS 3419

Plantaginaceae

Plantago helleri Small, cedar plantain. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2388, Coryell Co.: LS 2248

Plantago lanceolata L., English plantain. Introduced, biennial or perennial. Rare on disturbed roadside shoulder. Bell Co.: **LH 5068**

Plantago patagonica Jacq., bristle-bract plantain. Native, annual. Frequent in sandy soils, post oak woodlands, and disturbed areas. Bell Co.: **LS 2763**, Coryell Co.: **LS 3375**

Plantago rhodosperma Decne., red-seed plantain. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 3276, Coryell Co.: LS 2701

Plantago virginica L., pale-seed plantain. Native, annual. Frequent in alluvial soil along creek and river banks. Bell Co.: LS 2731, Coryell Co.: LH 5757

Plantago wrightiana Decne., Wright's plantain. Native, annual. Frequent in grasslands and disturbed areas. Bell Co.: LS 3267, Coryell Co.: LS 2823

Platanaceae

Platanus occidentalis L., American sycamore. Native, perennial. Common along gravelly creek beds and at springs in mesic canyons. Bell Co.: LH 5054, Coryell Co.: LS 3295

Polemoniaceae

Giliastrum incisum (Benth.) J.M. Porter, split-leaf gilia. Native, annual. Occasional on dry limestone slopes and mesas. Bell Co.: GG 360, Coryell Co.: **LH 5850**

Ipomopsis rubra (L.) Wherry, standing cypress. Native, annual or biennial. Common in grasslands and disturbed areas. Bell Co.: LS 2592, Coryell Co.: **LS 2827**

Phlox drummondii Hook. ssp. *mcallisteri* (Whitehouse) Wherry, McAllister's phlox. Native, annual. Occasional on sandy soils and post oak woodlands. Bell Co.: **CC 1697**, Coryell Co.: **LH 5878**

***Phlox roemeriana* Scheele,** gold-eye phlox. Native, annual. Occasional in grasslands and open woodlands. Bell Co.: LS 4648, Coryell Co.: LH 6379

Phlox villosissima (A. Gray) Small, downy phlox. Native, perennial. Occasional in gravelly alluvium of creeks and adjacent slopes. Bell Co.: CLGY 55048 (HABAYC), Coryell Co.: **LH 4747**

Polygalaceae

Polygala alba Nutt., white milkwort. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 1850, Coryell Co.: LS 2296

Polygala incarnata L., pink milkwort. Native, annual. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **WRC 17580**

Polygala lindheimeri A. Gray var. *parvifolia* Wheelock, shrubby milkwort. Native, perennial. Frequent in grasslands on dry rocky limestone. Bell Co.: **LS 3579**, Coryell Co.: LH 6069

Polygala verticillata L., whorled milkwort. Native, annual. Frequent in grasslands over limestone or sand. Bell Co.: **LH 4951**, Coryell Co.: **LS 1466**

Polygonaceae

Eriogonum annuum Nutt., annual wild buckwheat. Native, annual or biennial. Occasional in grasslands and disturbed areas. Coryell Co.: LS 1472

Eriogonum longifolium Nutt. var. *longifolium*, long-leaf wild buckwheat. Native, perennial. Frequent in sandy soils and post oak woodlands. Bell Co.: LS 2039, Coryell Co.: LS 2916

Polygonum aviculare L., prostrate knotweed. Introduced, annual or perennial. Frequent in disturbed areas. Bell Co.: LH 5910, Coryell Co.: **LS 2603**

Polygonum lapathifolium L., willow smartweed. Native, annual. Frequent in damp mud along creeks and ponds. Bell Co.: LH 6104, Coryell Co.: **LS 4499**

Polygonum pensylvanicum L., pink smartweed. Native, annual. Frequent along creeks and ponds. Bell Co.: **LH 6068**, Coryell Co.: LS 4500

Polygonum punctatum Elliot, water smartweed. Native, annual or perennial. Common in damp mud along creeks and ponds. Bell Co.: LH 5533, Coryell Co.: **LS 4469**

Polygonum ramosissimum Michx., bushy knotweed. Native, annual. Frequent in damp soil and disturbed areas. Bell Co.: **LH 6103**, Coryell Co.: **LS 2888**

Rumex altissimus Alph. Wood, pale dock. Native, biennial or perennial. Rare in damp mud along creeks, ponds, and roadside ditches. Bell Co.: CLGY 54229 (HABAYC), Coryell Co.: **LH 6314**

Rumex chrysocarpus Moris, amamastla. Native, perennial. Rare in damp mud along creeks, ponds, and roadside ditches. Bell Co.: LH 6373, Coryell Co.: **LH 6815**

Rumex crispus L., curly dock. Introduced, perennial. Common in damp mud along creeks, ponds, and roadside ditches. Bell Co.: LH 4920, Coryell Co.: **LH 6543**

Rumex hastatulus Baldw., heart-wing sorrel. Native, perennial. Frequent on sandy soils and post oak woodlands. Bell Co.: CLGY 54245 (HABAYC), Coryell Co.: LH 5668

Rumex pulcher L., fiddle dock. Introduced, perennial. Common in damp mud along creeks, ponds, and roadside ditches. Bell Co.: LH 6374, Coryell Co.: **LS 2462**

Portulacaceae

Claytonia virginica L., Virginia spring-beauty. Native, perennial. Rare in open woodlands. Bell Co.: LH 6677

Portulaca oleracea L., common purslane. Introduced, annual. Frequent on limestone mesatops and disturbed areas. Bell Co.: LH 5174, Coryell Co.: **LS 2891**

Portulaca pilosa L., chisme. Native, annual. Frequent on limestone mesatops and dry grasslands. Bell Co.: LS 2967, Coryell Co.: **LS 2890**

Primulaceae

Anagallis arvensis L., scarlet pimpernel. Introduced, annual. Occasional in disturbed grasslands. Bell Co.: **LS 4384**, Coryell Co.: **LH 6613**

Samolus ebracteatus Kunth ssp. *cuneatus* (Small) R. Knuth, limerock brookweed. Native, perennial. Occasional on seeping limestone in riparian areas and mesic wooded canyons. Bell Co.: RKGL 501

Samolus valerandi L. ssp. *parviflorus* (Raf.) Hulten, thin-leaf brookweed. Native, perennial. Common on seeping limestone in riparian areas and mesic wooded canyons. Bell Co.: LH 5473, Coryell Co.: **LS 3965**

Punicaceae

Punica granatum L., pomegranate. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LH 6047**, Coryell Co.: **LS 2774**

Rafflesiaceae

Pilostyles thurberi A. Gray, Thurber's pilostyles. Native, perennial. Rare in woodlands, parasitizing *Dalea frutescens*. Bell Co.: JJ s.n., Coryell Co.: **LH 5466**

Ranunculaceae

Anemone berlandieri Pritz., wind-flower. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2116, Coryell Co.: LS 2123

Aquilegia canadensis L., common columbine. Native, perennial. Frequent on limestone in mesic wooded canyons. Bell Co.: LH 5582, Coryell Co.: **LH 5611**

Clematis drummondii Torr. & A. Gray, Drummond's clematis. Native, perennial. Frequent in open woodlands, climbing onto shrubs. Bell Co.: **LS 1959**, Coryell Co.: **LS 2100**

Clematis pitcheri Torr. & A. Gray var. *pitcheri*, purple leatherflower. Native, perennial. Common along banks of creeks and ponds, climbing onto shrubs. Bell Co.: LS 3304, Coryell Co.: **LS 3887**

***Clematis texensis* Buckley,** scarlet clematis. Native, perennial. Frequent in mesic wooded canyons and on limestone mesatops, climbing onto shrubs. Bell Co.: LH 6023, Coryell Co.: LH 6022

Delphinium carolinianum Walter ssp. *virescens* (Nutt.) R.E. Brooks, prairie larkspur. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2724, Coryell Co.: **LS 2554**

Ranunculus fascicularis Muhl. ex Bigelow, early buttercup. Native, perennial. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 6739**

Ranunculus macranthus Scheele, showy buttercup. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: CLGY 54149 (HABAYC), Coryell Co.: LS 2646

Ranunculus sceleratus L., blister buttercup. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5530, Coryell Co.: **LS 4440**

Rhamnaceae

Berchemia scandens (Hill) K. Koch, supple-jack. Native, perennial. Common along riparian corridors and in mesic canyons, climbing onto shrubs and trees. Bell Co.: LS 2683, Coryell Co.: **LH 4745**

Ceanothus herbaceus Raf., redroot. Native, perennial. Common on dry rocky limestone slopes. Bell Co.: LS 4642, Coryell Co.: LH 6547

Frangula caroliniana (Walter) A. Gray, Carolina buckthorn. Native, perennial. Common in most woodlands, especially mesic woodlands. Bell Co.: LS 2506, Coryell Co.: **LS 2665**

Ziziphus zizyphus (L.) Karst., common jujube. Introduced, perennial. Frequent near old homesites, cultivated, naturalized. Bell Co.: LS 2784, Coryell Co.: LS 3312

Rosaceae

Crataegus crus-galli L., cockspur hawthorn. Native, perennial. Rare in open woodland. Coryell Co.: **LH 5758**

Geum canadense Jacq. var. *canadense*, plains white avens. Native, perennial. Common in shade along riparian corridors. Bell Co.: LS 3269, Coryell Co.: **LS 3291**

Photinia serratifolia (Desf.) Kalkm., Chinese photinia. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LH 6601**, Coryell Co.: **LH 5614**

Prunus mexicana S. Watson, Mexican plum. Native, perennial. Common in most woodlands. Bell Co.: JS 4234, Coryell Co.: **LS 4616**

Prunus munsoniana W. Wight & Hedrick, wildgoose plum. Native, perennial. Frequent along banks of creeks and in other damp areas. Bell Co.: **LS 4659**, Coryell Co.: **LS 4623**

Prunus persica (L.) Batsch, peach. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LS 4622**, Coryell Co.: **LS 1708**

Prunus rivularis Scheele, creek plum. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: **LS 4628**, Coryell Co.: LS 2645

***Prunus serotina* Ehrh. var. *eximia* (Small) Little,** Escarpment black cherry. Native, perennial. Rare in mesic wooded limestone canyons. Bell Co.: **LH 5002**, Coryell Co.: **BH s.n.**

Prunus umbellata Elliot, flatwood plum. Native, perennial. Occasional in open woodlands. Bell Co.: **LS 734**

Pyracantha coccinea M. Roem., scarlet fire-thorn. Introduced, perennial. Rare at old homesites and wildlife foodplots, cultivated, persisting. Coryell Co.: **LS 3627**

Pyracantha koidzumii (Hayata) Rehder, Formosa fire-thorn. Introduced, perennial. Rare at old homesites and wildlife foodplots, cultivated, persisting. Bell Co.: LS 4594, Coryell Co.: LH 5376

Pyrus calleryana Decne., Bradford pear. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LS 4621**, Coryell Co.: **LH 6676**

Pyrus communis L., common pear. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LH 5585**, Coryell Co.: **LS 2120**

Rosa eglanteria L., sweet briar rose. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: LH 5941

Rosa multiflora Thunb., Japanese rose. Introduced, perennial. Rare at old homesites, cultivated, persisting. Coryell Co.: RTBS 213

Rosa sp., antique rose. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: LH 5938, Coryell Co.: LS 2705

Rubus aboriginum Rydb., aboriginal dewberry. Native, perennial. Common in open woodlands. Bell Co.: **LS 2515**, Coryell Co.: **LS 1434**

Rubus bifrons Vest ex Tratt., two-leafed blackberry. Introduced, perennial. Occasional near old homesites, cultivated, naturalized. Bell Co.: LH 4939, Coryell Co.: LS 2400

Rubus trivialis Michx., southern dewberry. Native, perennial. Common in most habitats. Bell Co.: LS 1794, Coryell Co.: LH 4662

Sanguisorba annua (Nutt. ex Hook.) Nutt. ex Torr. & A. Gray, prairie burnet. Native, annual. Rare on sandy soils and post oak woodlands. Bell Co.: **LH 6737**, Coryell Co.: **LH 4919**

Rubiaceae

Cephalanthus occidentalis L., common buttonbush. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2591, Coryell Co.: LS 3566

Diodia teres Walter var. *teres*, poor-Joe. Native, annual. Frequent on sandy Pleistocene terrace deposits of the Leon River. Bell Co.: CLGY 55102 (HABAYC), Coryell Co.: **LS 3417**

Diodia virginiana L., Virginia buttonweed. Native, perennial. Occasional along streams and other damp sites. Bell Co.: **LH 5168**, Coryell Co.: **LH 5485**

Galium aparine L., catchweed bedstraw. Introduced, annual. Frequent in mesic woodlands and disturbed areas. Bell Co.: LS 2316, Coryell Co.: **LS 2262**

Galium circaezans Michx., woods bedstraw. Native, perennial. Frequent in shade of mesic limestone canyons. Bell Co.: LS 1993, Coryell Co.: LS 2748

Galium texense A. Gray, Texas bedstraw. Native, annual or perennial. Frequent in shade of mesic limestone canyons. Bell Co.: LS 1870, Coryell Co.: **LS 2651**

Galium virgatum Nutt., southwest bedstraw. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 2197, Coryell Co.: LS 2652

Houstonia pusilla Schoepf, tiny bluet. Native, annual. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 5597**

Sherardia arvensis L., spurwort. Introduced, annual. Occasional in disturbed areas, along creek banks, and in lawns. Bell Co.: LH 5606, Coryell Co.: **LH 5605**

Stenaria nigricans (Lam.) Terrell var. *nigricans*, prairie bluets. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2479, Coryell Co.: LS 2430

Rutaceae

Ptelea trifoliata L. ssp. *angustifolia* (Benth.) V. Bailey var. *persicifolia* (Greene) V. Bailey, narrow-leaf hoptree. Native, perennial. Common in most woodlands, especially mesic woodlands. Bell Co.: **LH 5145**, Coryell Co.: **LH 5049**

Ptelea trifoliata L. ssp. *trifoliata* var. *mollis* Torr. & A. Gray, woolly hoptree. Native, perennial. Common in most woodlands, especially mesic woodlands. Bell Co.: LS 2765, Coryell Co.: LS 1945

Thamnosma texanum (A. Gray) Torr., rue of the mountains. Native, perennial. Rare in grasslands on dry rocky limestone. Coryell Co.: BT 3810 (TEX)

Zanthoxylum clava-herculis L., Hercules' club. Native, perennial. Rare on sandy soils and post oak woodlands. Bell Co.: GG 359, Coryell Co.: **LS 3387**

Zanthoxylum hirsutum Buckley, prickly-ash. Native, perennial. Common in open woodlands. Bell Co.: **LS 1782**, Coryell Co.: LS 2617

Salicaceae

Populus deltoides Bartram ex Marsh. ssp. *deltoides*, eastern cottonwood. Native, perennial. Common along riparian corridors. Bell Co.: LH 4929, Coryell Co.: LS 4643

Salix nigra Marsh., black willow. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: GG 362, Coryell Co.: LH 4660

Sapindaceae

Cardiospermum halicacabum L., common balloonvine. Introduced, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5527, Coryell Co.: LS 1933

Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson, western soapberry. Native, perennial. Common along riparian corridors and in open woodlands. Bell Co.: LS 2594, Coryell Co.: LS 2548

Ungnadia speciosa Endl., Mexican buckeye. Native, perennial. Common on limestone slopes, canyons, and mesas. Bell Co.: GG 356, Coryell Co.: LS 2638

Sapotaceae

Sideroxylon lanuginosum Michx. ssp. *albicans* (Sarg.) Kartesz & Gandhi, chittamwood. Native, perennial. Common in most woodlands. Bell Co.: LS 4393, Coryell Co.: LH 5014

Scrophulariaceae

Agalinis densiflora (Benth.) Blake, fine-leaf gerardia. Native, annual. Frequent in grasslands on dry rocky limestone. Bell Co.: LH 5162, Coryell Co.: LH 6166

Agalinis heterophylla (Nutt.) Small ex Britton, prairie agalinis. Native, annual. Common in grasslands on rocky limestone. Bell Co.: LS 2954, Coryell Co.: LS 4497

Bacopa monnieri (L.) Pennell, coastal water-hyssop. Native, perennial. Occasional in mud of ponds and lakes. Bell Co.: LH 5461, Coryell Co.: **LS 4487**

Bacopa rotundifolia (Michx.) Wettst., disc water-hyssop. Native, perennial. Rare in mud of a pond. Bell Co.: **LH 4965**

Buchnera floridana Gand., bluehearts. Native, perennial. Common in seasonally seeping limestone grasslands and along unshaded creek banks. Bell Co.: **LH 5155**, Coryell Co.: **LH 5164**

Castilleja indivisa Engelm., Texas paintbrush. Native, annual. Common in grasslands. Bell Co.: LH 5905, Coryell Co.: LS 2279

***Castilleja purpurea* (Nutt.) G. Don var. *lindheimeri* (A. Gray) Shinners**, prairie paintbrush. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LH 5761, Coryell Co.: **LH 5763**

Castilleja purpurea (Nutt.) G. Don var. *purpurea*, downy Indian paintbrush. Native, perennial. Occasional in grasslands on rocky limestone. Coryell Co.: LH 6346

Dasistoma macrophylla (Nutt.) Raf., mullein seymeria. Native, perennial. Rare in mesic wooded canyons. Bell Co.: **LH 6631**, Coryell Co.: **LH 5125**

Leucospora multifida (Michx.) Nutt., narrow-leaf conobea. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5153, Coryell Co.: **LS 2030**

Maurandella antirrhiniflora (Humb. & Bonpl. ex Willd.) Rothm., snapdragon vine. Native, perennial. Occasional along limestone cliffs above Belton Lake, climbing onto shrubs. Bell Co.: **LS 4383**, Coryell Co.: **LH 6667**

Mecardonia procumbens (Mill.) Small, prostrate water-hyssop. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 3626, Coryell Co.: **LS 4395**

Nuttallanthus texanus (Scheele) D.A. Sutton, Texas toad-flax. Native, annual. Occasional on sandy soils and post oak woodlands. Bell Co.: LH 6717, Coryell Co.: **LH 4668**

Penstemon cobaea Nutt., wild foxglove. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: GG 364, Coryell Co.: LH 6349

Penstemon laxiflorus Pennell, loose-flowered penstemon. Native, perennial. Rare on sandy soils and post oak woodlands. Coryell Co.: **LS 1462**

Verbascum thapsus L., common mullein. Introduced, biennial. Frequent in disturbed areas. Bell Co.: LS 4386, Coryell Co.: **LS 3582**

Veronica anagallis-aquatica L., water speedwell. Introduced, perennial. Frequent along banks of creeks and rivers. Bell Co.: **LH 5621**, Coryell Co.: **LH 5756**

Veronica arvensis L., common speedwell. Introduced, annual. Frequent in damp soil and disturbed areas. Bell Co.: **LS 1658**, Coryell Co.: **LS 2269**

Veronica peregrina L. ssp. *xalapensis* (Kunth) Pennell, Jalapa speedwell. Native, annual. Frequent in damp soil and disturbed areas. Bell Co.: LH 6336, Coryell Co.: **LS 2455**

Veronica polita Fries, gray field speedwell. Introduced, annual. Rare in disturbed areas and lawns. Bell Co.: **LH 6680**, Coryell Co.: **LS 4602**

Simaroubaceae

Ailanthus altissima (Mill.) Swingle, tree-of-heaven. Introduced, perennial. Occasional near old homesites, cultivated, naturalized. Bell Co.: **LH 6415**, Coryell Co.: **LH 6633**

Solanaceae

Bouchetia erecta DC., erect bouchetia. Native, perennial. Rare in grasslands on dry rocky limestone. Bell Co.: LH 4909

Calibrachoa parviflora (Juss.) D'Arcy, seaside petunia. Native, annual. Rare in mud of ponds and lakes. Bell Co.: SJC T1 (TEX)

Chamaesaracha coniodes (Moric. ex Dunal) Britton, gray five eyes. Native, perennial. Frequent in grasslands and disturbed areas. Bell Co.: **LH 5888**, Coryell Co.: **LS 4644**

Chamaesaracha edwardsiana Averett, Plateau false nightshade. Native, perennial. Frequent in grasslands and disturbed areas. Bell Co.: **LH 5856**, Coryell Co.: **LS 2667**

Chamaesaracha sordida (Dunal) A. Gray, hairy false nightshade. Native, perennial. Frequent in grasslands and disturbed areas. Bell Co.: LH 5766

Datura inoxia Mill., Indian-apple. Introduced, perennial. Frequent in sandy alluvium along streams and in disturbed areas. Bell Co.: **LH 6248**, Coryell Co.: **LS 3431**

Datura stramonium L., Jimson-weed. Introduced, annual. Rare in disturbed areas. Bell Co.: CLGY 55B1 (HABAYC)

Datura wrightii Regel, sacred thorn-apple. Native, perennial. Frequent in sandy alluvium along streams and in disturbed areas. Bell Co.: LH 6063, Coryell Co.: LH 6160

Physalis angulata L., cut-leaf ground-cherry. Native, annual. Frequent in sandy and gravelly alluvium along streams. Bell Co.: LS 2860, Coryell Co.: **LS 4490**

Physalis cinerascens (Dunal) Hitchc. var. *cinerascens*, yellow ground-cherry. Native, perennial. Common in open woodlands and disturbed areas. Bell Co.: LS 2777, Coryell Co.: **LS 2525**

Physalis heterophylla Nees, clammy ground-cherry. Native, perennial. Common in open woodlands and disturbed areas. Bell Co.: LS 1705, Coryell Co.: **LS 2741**

Physalis mollis Nutt. var. *mollis*, field ground-cherry. Native, perennial. Common on sandy soils and post oak woodlands. Bell Co.: **LS 1775**, Coryell Co.: **LS 2825**

Solanum dimidiatum Raf., western horse-nettle. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2935, Coryell Co.: **LS 1898**

Solanum elaeagnifolium Cav., silver-leaf nightshade. Native, perennial. Common in disturbed grasslands. Bell Co.: **LS 3262**, Coryell Co.: **LS 2447**

Solanum ptycanthum Dunal, American nightshade. Introduced, annual. Frequent in mesic woodlands. Bell Co.: LS 2805, Coryell Co.: **LS 2849**

Solanum rostratum Dunal, buffalo-bur. Native, annual. Common in disturbed grasslands. Bell Co.: **LS 1956**, Coryell Co.: **LS 2541**

Solanum triquetrum Cav., Texas nightshade. Native, perennial. Occasional in mesic woodlands. Bell Co.: LH 4972, Coryell Co.: LS 1710

Sterculiaceae

Melochia pyramidata L., pyramid-flower. Native, perennial. Occasional in disturbed areas and in recent landscape plantings. Bell Co.: **LH 6668**

Styracaceae

***Styrax platanifolius* Engelm. ssp. *platanifolius*,** sycamore-leaf snowbell. Native, perennial. Frequent in mesic wooded limestone canyons. Bell Co.: WRC 17396, Coryell Co.: LH 5759

Tamaricaceae

Tamarix ramosissima Ledeb., salt-cedar. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LH 6067**, Coryell Co.: **LH 6637**

Ulmaceae

Celtis laevigata Willd. var. *laevigata*, Texas sugarberry. Native, perennial. Common along riparian corridors. Bell Co.: LH 5900, Coryell Co.: LH 4669

Celtis laevigata Willd. var. *reticulata* (Torr.) L.D. Benson, net-leaf hackberry. Native, perennial. Common on dry limestone slopes and mesas. Bell Co.: LS 2970, Coryell Co.: LS 2704

Celtis laevigata Willd. var. *texana* Sarg., Texas hackberry. Native, perennial. Common in mesic woodlands. Bell Co.: LS 4633, Coryell Co.: LS 3684

Ulmus americana L., American elm. Native, perennial. Common along riparian corridors. Bell Co.: WRC 17586, Coryell Co.: **LS 3659**

Ulmus crassifolia Nutt., cedar elm. Native, perennial. Common in most woodlands. Bell Co.: LH 5285, Coryell Co.: LH 5272

Ulmus rubra Muhl., slippery elm. Native, perennial. Occasional along riparian corridors. Coryell Co.: **JW 277**

Urticaceae

Boehmeria cylindrica (L.) Sw., bog-hemp. Native, perennial. Rare along banks of creeks and rivers. Bell Co.: LH 6100

Parietaria pensylvanica Muhl. ex Willd., Pennsylvania pellitory. Native, annual. Common in shade of woodlands and disturbed areas. Bell Co.: LS 1685, Coryell Co.: LS 2650

Urtica chamaedryoides Pursh, stinging nettle. Native, annual. Frequent in shade of mesic limestone canyons and along riparian corridors. Bell Co.: LS 2137, Coryell Co.: **LS 2631**

Valerianaceae

Valerianella amarella (Lindh. ex Engelm.) Krok, hairy cornsalad. Native, annual. Common in grasslands on rocky limestone. Bell Co.: LH 4826, Coryell Co.: **LH 5676**

Valerianella radiata (L.) Dufr., beaked cornsalad. Native, annual. Common in grasslands on rocky limestone. Bell Co.: LS 2335, Coryell Co.: **LH 6550**

Verbenaceae

Callicarpa americana L., American beauty-berry. Native, perennial. Common in mesic wooded canyons and along riparian corridors. Bell Co.: LS 1968, Coryell Co.: LS 3972

Glandularia bipinnatifida (Nutt.) Nutt. var. *bipinnatifida*, Dakota vervain. Native, perennial. Common in grasslands on rocky limestone and disturbed areas. Bell Co.: LS 2213, Coryell Co.: LS 4645

Glandularia pumila (Rydb.) Umber, pink vervain. Native, annual. Common in grasslands and on limestone mesatops. Bell Co.: LS 2115, Coryell Co.: **LS 1438**

Lantana camara L., West Indian lantana. Introduced, perennial. Frequent near old homesites, cultivated, naturalized. Bell Co.: LS 1508, Coryell Co.: **LH 6570**

Lantana urticoides Hayek, Texas lantana. Native, perennial. Common in woodlands and open areas. Bell Co.: LS 1784, Coryell Co.: LS 2742

Phryma leptostachya L., American lopseed. Native, perennial. Frequent in mesic wooded canyons. Bell Co.: LS 4392, Coryell Co.: **LH 5126**

Phyla nodiflora (L.) Greene, Texas frog-fruit. Native, perennial. Common along banks of creeks and in disturbed grasslands. Bell Co.: LS 2500, Coryell Co.: **LS 2420**

Verbena brasiliensis Vell., Brazilian vervain. Introduced, perennial. Frequent along banks of creeks and rivers. Bell Co.: LH 4934, Coryell Co.: LS 4394

Verbena canescens Kunth, gray vervain. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 4653, Coryell Co.: LS 3498

Verbena halei Small, Texas vervain. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2390, Coryell Co.: **LS 2434**

Verbena scabra Vahl, harsh vervain. Native, perennial. Occasional along banks of creeks and rivers. Bell Co.: LH 6096, Coryell Co.: WRC 17734

Verbena xutha Lehm., coarse vervain. Native, perennial. Occasional in grasslands and disturbed areas. Bell Co.: LS 4387, Coryell Co.: **LS 1471**

Vitex agnus-castus L. var. *agnus-castus*, common chaste-tree. Introduced, perennial. Common near old homesites, cultivated, naturalized. Bell Co.: LS 4385, Coryell Co.: **LS 3893**

Violaceae

Hybanthus verticillatus (Ortega) Baill., nodding green-violet. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: LH 6062, Coryell Co.: LH 6540

Viola bicolor Pursh, field pansy. Native, annual. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **LH 5594**

Viola missouriensis Greene, Missouri violet. Native, perennial. Common in shade of riparian corridors and mesic wooded canyons. Bell Co.: LS 2109, Coryell Co.: **LS 2632**

Viola sororia Willd., sister violet. Native, perennial. Common in shade of riparian corridors and mesic wooded canyons. Bell Co.: LH 5577, Coryell Co.: **LH 5581**

Viscaceae

Phoradendron tomentosum (DC.) Engelm. ex A. Gray, Christmas mistletoe. Native, perennial. Common in woodlands, hemiparasite of trees. Bell Co.: LS 2134, Coryell Co.: **LS 2125**

Vitaceae

Ampelopsis arborea (L.) Koehne, pepper-vine. Native, perennial. Common in sun along creeks and streams, especially at margins of riparian corridors. Bell Co.: LS 1985, Coryell Co.: **LS 2817**

Ampelopsis cordata Michx., heart-leaf ampelopsis. Native, perennial. Common along wooded riparian corridors, climbing onto shrubs and trees. Bell Co.: **LH 4902**, Coryell Co.: LS 2816

Cissus trifoliata (L.) L., sorrelvine. Native, perennial. Frequent in woodlands, climbing onto shrubs. Bell Co.: LH 4971, Coryell Co.: **LS 2906**

Parthenocissus heptaphylla **(Buckley) Britton ex Small,** seven-leaf creeper. Native, perennial. Common on limestone slopes and mesas, climbing onto shrubs. Bell Co.: LH 5967, Coryell Co.: **LH 5962**

Parthenocissus quinquefolia (L.) Planch., Virginia creeper. Native, perennial. Common along wooded riparian corridors, climbing onto shrubs and trees. Bell Co.: LS 1977, Coryell Co.: **LH 6611**

Vitis cinerea (Engelm.) Engelm. ex Millard var. *helleri* (L.H. Bailey) M.O. Moore, winter grape. Native, perennial. Common in most woodlands, climbing onto shrubs and trees. Bell Co.: LS 2319, Coryell Co.: LS 2677

Vitis monticola **Buckley,** sweet mountain grape. Native, perennial. Common on dry limestone slopes and mesas, climbing onto shrubs. Bell Co.: LH 5849, Coryell Co.: LH 5846

Vitis mustangensis Buckley, mustang grape. Native, perennial. Common in most woodlands, especially in sandy soil and along riparian corridors, climbing onto shrubs and trees. Bell Co.: LS 2318, Coryell Co.: **LS 1821**

Vitis vulpina L., fox grape. Native, perennial. Common along riparian corridors, climbing onto shrubs and trees. Bell Co.: LS 1869, Coryell Co.: **LH 4903**

Zygophyllaceae

Kallstroemia parviflora J.B.S. Norton, warty caltrop. Native, annual. Occasional in sandy soil and disturbed areas. Bell Co.: LH 6673, Coryell Co.: **LS 4484**

MAGNOLIOPHYTA: Monocotyledonae

Agavaceae

Agave americana L., American century plant. Native, perennial. Rare at old homesites and illegal dump sites, cultivated, persisting. Bell Co.: **LH 6572**, Coryell Co.: **LH 6534**

Hesperaloe parviflora (Torr.) J.M. Coult., red-flower false yucca. Native, perennial. Rare among construction debris, possibly a waif, persisting. Coryell Co.: **LH 6679**

Nolina lindheimeriana **(Scheele) S. Watson,** devil's shoestring. Native, perennial. Common on dry rocky limestone slopes. Bell Co.: **LH 6021**, Coryell Co.: **LH 5007**

Nolina texana S. Watson, Texas sacahuista. Native, perennial. Common on shaded limestone slopes and in grasslands on dry rocky limestone. Bell Co.: **LS 2681**, Coryell Co.: **LS 2295**

Yucca arkansana Trel., Arkansas yucca. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: LH 5887, Coryell Co.: LS 1894

Yucca constricta Buckley, Buckley's yucca. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: **LS 1487**

Yucca constricta Buckley x *Y. louisianensis* Trel., hybrid yucca. Native, perennial. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: WRC 17587

Yucca pallida **McKelvey,** pale yucca. Native, perennial. Common on rocky limestone grasslands, slopes, and mesas. Bell Co.: LH 4931, Coryell Co.: LH 5101

Yucca rupicola **Scheele**, Texas yucca. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: LH 5185, Coryell Co.: **LH 6548**

Yucca treculeana Carr., Spanish-dagger. Native, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LS 4652**, Coryell Co.: **LH 6719**

Alismataceae

Echinodorus berteroi (Spreng.) Fassett, burhead. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5284, Coryell Co.: LS 1934

Sagittaria calycina Engelm. var. *calycina*, giant arrowhead. Native, perennial. Frequent in shallow water or mud near banks of creeks and ponds. Bell Co.: **LH 5263**

Sagittaria platyphylla (Engelm.) J.G. Sm., delta arrowhead. Native, perennial. Common in shallow water or mud near banks of creeks and ponds. Bell Co.: LH 5264, Coryell Co.: **LH 5390**

Araceae

Arisaema dracontium (L.) Schott, green-dragon. Native, perennial. Frequent in mesic wooded canyons and along riparian corridors. Bell Co.: LH 4917, Coryell Co.: LH 4899

Xanthosoma sagittifolium (L.) Schott, arrow-leaf elephant's ear. Introduced, perennial. Rare at damp areas near old homesites, cultivated, persisting. Bell Co.: **LS 761**

Bromeliaceae

Tillandsia recurvata (L.) L., small ball-moss. Native, perennial. Occasional in mesic woodlands, epiphyte on trees. Bell Co.: LH 5146, Coryell Co.: **LH 5616**

Commelinaceae

Commelina diffusa Burm. f., climbing dayflower. Native, annual. Rare on sandy Pleistocene terrace deposits. Bell Co.: **LH 6163**

Commelina erecta L. var. *angustifolia* (Michx.) Fernald, whitemouth dayflower. Native, perennial. Occasional on sandy soil and post oak woodlands. Bell Co.: **LH 6802**, Coryell Co.: **LH 5456**

Commelina erecta L. var. *erecta*, erect dayflower. Native, perennial. Common along riparian corridors and woodland edges. Bell Co.: LS 2587, Coryell Co.: **LS 2882**

Tinantia anomala (Torr.) C.B. Clarke, false dayflower. Native, annual. Frequent in mesic woodlands and along riparian corridors. Bell Co.: LH 5622, Coryell Co.: LH 5010

Tradescantia edwardsiana **Tharp,** Plateau spiderwort. Native, perennial. Frequent in mesic wooded canyons. Bell Co.: JS 4229, Coryell Co.: LH 5639

Tradescantia gigantea Rose, giant spiderwort. Native, perennial. Frequent in mesic woodlands and along riparian corridors. Coryell Co.: LS 1730

Tradescantia humilis **Rose,** Texas spiderwort. Native, perennial. Frequent along riparian corridors and woodland edges. Bell Co.: LH 6407, Coryell Co.: **LH 5650**

Tradescantia occidentalis (Britton) Smyth, prairie spiderwort. Native, perennial. Frequent in open woodlands and grasslands. Bell Co.: LH 6742, Coryell Co.: LS 2273

Cyperaceae

Carex austrina (Small) Mack., southern caric sedge. Native, perennial. Rare in grasslands. Bell Co.: LS 1796, Coryell Co.: **LH 5845**

Carex blanda Dewey, charming caric sedge. Native, perennial. Frequent along wooded riparian corridors. Bell Co.: LH 5683, Coryell Co.: **LH 5604**

Carex bulbostylis Mack., globose caric sedge. Native, perennial. Frequent along wooded riparian corridors. Bell Co.: LS 1479, Coryell Co.: **LH 4663**

Carex corrugata Fernald, wrinkle-fruit caric sedge. Native, perennial. Occasional on sandy alluvium. Coryell Co.: **LS 1909**

***Carex edwardsiana* Bridges & Orzell,** Edwards Plateau caric sedge. Native, perennial. Common in mesic wooded canyons. Bell Co.: LH 5583, Coryell Co.: LH 5613

Carex emoryi Dewey, Emory's sedge. Native, perennial. Rare along banks of creeks. Coryell Co.: **LH 6816**

Carex frankii Kunth, Joseph Frank's caric sedge. Native, perennial. Rare along banks of creeks. Bell Co.: LS 2719

Carex lurida Wahlenb., sallow sedge. Native, perennial. Rare along banks of creeks and in other damp areas. Bell Co.: **LH 5926**, Coryell Co.: **LH 5948**

Carex microdonta Torr. & Hook., small-tooth caric sedge. Native, perennial. Common along banks of creeks and ponds and in other damp areas. Bell Co.: LH 5890, Coryell Co.: LH 5898

Carex muehlenbergii Schkuhr ex Willd. var. *enervis* Boott, Muhlenberg's veinless caric sedge. Native, perennial. Common in post oak woodlands and on sandy alluvium. Bell Co.: LH 5682, Coryell Co.: **LS 2755**

Carex perdentata S.D. Jones, conspicuously-toothed caric sedge. Native, perennial. Frequent along wooded riparian corridors. Bell Co.: LS 2768, Coryell Co.: **LS 3287**

Carex planostachys Kunze, cedar sedge. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2132, Coryell Co.: LS 2124

Carex tetrastachya Scheele, four-angle caric sedge. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5769, Coryell Co.: LH 5881

Cladium mariscus (L.) Pohl ssp. *jamaicense* (Crantz) Kuk., sawgrass. Native, perennial. Rare on limestone ledges along banks of creeks and other damp areas. Bell Co.: **LS 2393**

Cyperus acuminatus Torr. & Hook. ex Torr., taper-leaf flat sedge. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5117, Coryell Co.: LH 5062

Cyperus eragrostis Lam., tall flat sedge. Native, perennial. Rare along banks of creeks. Coryell Co.: **SMKL 94**

Cyperus erythrorhizos Muhl., red-root flat sedge. Native, annual. Occasional along banks of creeks. Bell Co.: **LH 5262**

Cyperus esculentus L., yellow nut-sedge. Native, perennial. Occasional along banks of creeks and other damp areas. Coryell Co.: **LH 4999**

Cyperus lupulinus (Spreng.) Marcks ssp. *lupulinus*, slender flat sedge. Native, perennial. Frequent in open woodlands. Bell Co.: JW 196, Coryell Co.: **LS 3311**

Cyperus odoratus L., fragrant flat sedge. Native, annual or perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LH 6101, Coryell Co.: JW 283

Cyperus pseudothyrsiflorus (Kuk.) J. Rich. Carter & S.D. Jones, flat sedge. Native, perennial. Rare in damp soil. Bell Co.: **LH 6049**

Cyperus pseudovegetus Steud., marsh flat sedge. Native, perennial. Frequent along banks of creeks and other damp areas. Coryell Co.: **LS 2700**

Cyperus retroflexus Buckley, one-flower flat sedge. Native, perennial. Frequent in open woodlands. Bell Co.: LS s.n., Coryell Co.: LS 2075

Cyperus setigerus Torr. & Hook., flat sedge. Native, perennial. Rare in damp soil of roadside ditch. Bell Co.: SEW 2975 (TEX)

Cyperus squarrosus L., bearded flat sedge. Native, annual. Occasional along banks of creeks and other damp areas. Coryell Co.: **LH 5102**

Cyperus strigosus L., false nut-grass. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: **LH 5116**, Coryell Co.: **LH 5103**

Eleocharis geniculata (L.) Roem. & Schult., Canada spike-rush. Native, annual. Frequent along banks of creeks and other damp areas. Bell Co.: LH 5271, Coryell Co.: **LH 5540**

Eleocharis montevidensis Kunth, sand spike-rush. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: **LS 2513**, Coryell Co.: **LS 2456**

Eleocharis occulta S.G. Sm., limestone spike-rush. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: **LH 5891**

Eleocharis palustris (L.) Roem. & Schult. var. *palustris*, large-spike spike-rush. Native, perennial. Frequent along banks of creeks and ponds. Bell Co.: **LH 4933**, Coryell Co.: **LH 4946**

Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer, dwarf spike-rush. Native, perennial. Rare along banks of creeks and other damp areas. Bell Co.: **WRC 17738**, Coryell Co.: **LH 6194**

Eleocharis quadrangulata (Michx.) Roem. & Schult., square-stem spike-rush. Native, perennial. Frequent along banks of creeks and ponds. Bell Co.: LH 5899, Coryell Co.: LH 4945

Fimbristylis puberula (Michx.) Vahl var. *puberula*, hairy fimbry. Native, perennial. Rare in seasonally seeping limestone soil. Coryell Co.: LH 5304

Fimbristylis vahlii (Lam.) Link, Vahl's fimbristylis. Native, annual. Occasional along muddy banks of ponds. Bell Co.: LH 5281

Fuirena simplex Vahl var. *simplex*, umbrella sedge. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5151, Coryell Co.: **LH 5108**

Rhynchospora nivea Boeck., snowy white-top sedge. Native, perennial. Rare on limestone ledge along banks of creek. Bell Co.: LH 5152

Schoenoplectus californicus (C.A. Mey.) Palla, California bulrush. Native, perennial. Occasional along muddy banks of ponds. Bell Co.: LH 4994, Coryell Co.: **LH 4947**

Schoenoplectus pungens (Vahl) Palla, common three-square. Native, perennial. Rare along muddy banks of ponds. Bell Co.: **LH 5143**

Schoenoplectus saximontanus (Fernald) Raynal, Rocky Mountain bulrush. Native, annual or perennial. Occasional along muddy banks of ponds. Bell Co.: **LH 6207**, Coryell Co.: LH 6193

Scirpus pendulus Muhl., rufous bulrush. Native, perennial. Occasional along banks of creeks. Bell Co.: **LH 5908**

Scleria ciliata Michx., fringed nut-rush. Native, perennial. Rare on sandy Pleistocene terrace deposits of the Leon River. Coryell Co.: **WRC 17583**

Scleria oligantha Michx., little-head nut-rush. Native, perennial. Frequent in sandy soils and post oak woodlands. Bell Co.: LH 5930, Coryell Co.: **LH 5951**

Iridaceae

Iris germanica L., German iris. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: **LH 6337**, Coryell Co.: **LH 6345**

Iris pseudacorus L., pale yellow iris. Introduced, perennial. Rare along banks of a fishing pond, possibly a waif. Coryell Co.: **LH 6735**

Nemastylis geminiflora Nutt., prairie celestial. Native, perennial. Frequent in open areas of woodlands. Bell Co.: LH 5644, Coryell Co.: **LS 2193**

Sisyrinchium chilense Hook., sword-leaf blue-eyed grass. Native, perennial. Common in open woodlands, grasslands, and riparian areas. Bell Co.: **LH 4754**, Coryell Co.: LS 2297

Sisyrinchium minus Engelm. & A. Gray, dwarf blue-eyed grass. Native, annual. Frequent in sandy soil and post oak woodlands. Bell Co.: LH 6727, Coryell Co.: **LH 6734**

Sisyrinchium pruinosum Bickn., dotted blue-eyed grass. Native, perennial. Common in open woodlands and grasslands. Bell Co.: LH 5592, Coryell Co.: **LS 1905**

Juncaceae

Juncus brachycarpus Engelm., whiteroot rush. Native, perennial. Occasional in sandy soil. Coryell Co.: **LH 5672**

Juncus bufonius L., toad rush. Native, annual. Occasional in damp, sandy soil. Bell Co.: LH 5858

Juncus dichotomus Elliot, forked rush. Native, perennial. Common along banks of creeks and ponds, and other damp areas. Bell Co.: LH 5892, Coryell Co.: **LH 5854**

Juncus dudleyi Wiegand, Dudley's rush. Native, perennial. Occasional in damp soil. Bell Co.: **KSRS 869**, Coryell Co.: **LH 4958**

Juncus effusus L. var. *solutus* Fernald & Wiegand, common rush. Native, perennial. Occasional in damp soil. Bell Co.: LH 6480

Juncus filipendulus Buckley, ring-seed rush. Native, perennial. Frequent in damp soil. Bell Co.: LH 6018

Juncus interior Wiegand var. *interior*, inland rush. Native, perennial. Occasional in damp soil. Bell Co.: LH 5173, Coryell Co.: **JW 286**

Juncus marginatus Rostk., grass-leaf rush. Native, perennial. Occasional in damp areas of grasslands. Coryell Co.: **LH 5957**

Juncus texanus (Engelm.) Coville, Texas rush. Native, perennial. Common along banks of creeks and ponds, and other damp areas. Bell Co.: LH 5937, Coryell Co.: LH 4956

Juncus torreyi Coville, Torrey's rush. Native, perennial. Occasional in damp soil. Coryell Co.: **LS 2459**

Lemnaceae

Lemna aequinoctialis Welw., lesser duckweed. Native, annual. Rare in still water, floating. Bell Co.: CLGY 54315 (TEX)

Lemna minuta Kunth, least duckweed. Native, annual. Rare in still water, floating. Bell Co.: **LH 6573**

Lemna obscura (Austin) Daubs, little duckweed. Native, annual. Rare in still water, floating. Bell Co.: **LH 6650**, Coryell Co.: **LH 5453**

Spirodela polyrrhiza (L.) Schleid., common duckmeat. Native, annual. Rare in still water, floating. Bell Co.: **CLGY 54316** (HABAYC), Coryell Co.: **LH 5454**

Wolffia brasiliensis Weddell, Brazilian watermeal. Native, annual. Rare in still water, floating. Bell Co.: **LH 6574**, Coryell Co.: **LH 5452**

Liliaceae

Allium ampeloprasum L., broadleaf wild leek. Introduced, perennial. Occasional at old homesites, cultivated, persisting. Bell Co.: Bell **LH 6052**, Coryell Co.: **LS 2571**

Allium canadense L. var. *canadense*, Canada garlic. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 4828, Coryell Co.: **LH 4750**

Allium canadense L. var. *fraseri* Ownbey, Fraser meadow garlic. Native, perennial. Frequent in post oak woodlands and sandy alluvium. Bell Co.: **LH 6408**, Coryell Co.: **LS 1824**

Allium drummondii Regel, Drummond's wild onion. Native, perennial. Common in grasslands and open woodlands. Bell Co.: JS 4231, Coryell Co.: LS 2246

Allium porrum L., garden leek. Introduced, perennial. Rare at old homesites, cultivated, persisting. Coryell Co.: **LH 5970**

Allium sativum L., cultivated garlic. Introduced, perennial. Rare at old homesites, cultivated, persisting. Bell Co.: **LH 6649**

Allium stellatum Fraser ex Ker Gawl., prairie onion. Native, perennial. Occasional in grasslands and open woodlands. Bell Co.: **LS 2507**

Androstephium caeruleum (Scheele) Greene, blue funnel-lily. Native, perennial. Rare in grasslands. Bell Co.: LH 6695, Coryell Co.: **KSNH 793**

Camassia scilloides (Raf.) Cory, wild-hyacinth. Native, perennial. Occasional on limestone mesatops and slopes. Bell Co.: WRC 17305, Coryell Co.: **LS 2195**

Cooperia drummondii Herbert, cebolleta. Native, perennial. Common in grasslands. Bell Co.: **LH 5058**, Coryell Co.: **LS 2881**

Cooperia pedunculata Herbert, giant rain-lily. Native, perennial. Common in grasslands. Bell Co.: GG 343, Coryell Co.: **LH 5677**

Erythronium albidum Nutt., white dog-tooth-violet. Native, perennial. Common in mesic wooded canyons. Bell Co.: LS 4598, Coryell Co.: **LS 4613**

Erythronium mesochoreum Knerr, dog-tooth-violet. Native, perennial. Common on mesa tops, growing in shade of shrubs. Bell Co.: **LS 2259**, Coryell Co.: **LS 2647**

Muscari neglectum Guss. ex Ten., starch grape-hyacinth. Introduced, perennial. Occasional in disturbed areas, naturalized. Bell Co.: **LH 6681**, Coryell Co.: **LH 5603**

Nothoscordum bivalve (L.) Britton, crow-poison. Native, perennial. Common grasslands and open woodlands. Bell Co.: LS 4631, Coryell Co.: LS 3435

Zigadenus nuttallii (A. Gray) S. Watson, Nuttall's death-camas. Native, perennial. Frequent on limestone mesatops and along riparian corridors. Bell Co.: LH 6413, Coryell Co.: **LH 5602**

Najadaceae

Najas guadalupensis (Spreng.) Magnus ssp. *guadalupensis*, common water-nymph. Native, annual. Frequent in ponds and lakes, submersed. Bell Co.: LH 4995, Coryell Co.: **LH 4949**

Orchidaceae

Corallorhiza wisteriana Conrad, spring coralroot. Native, perennial. Occasional in leaf litter in mesic woodlands. Bell Co.: **LH 5584**, Coryell Co.: LH 5601

Hexalectris nitida L.O. Williams, shining hexalectris. Native, perennial. Frequent in juniper leaf litter on limestone slopes and mesatops. Bell Co.: LH 5115, Coryell Co.: LH 5111

Hexalectris spicata (Walter) Barnh. var. *arizonica* (S. Watson) Catling & Engel, spiked crested-coralroot. Native, perennial. Frequent in juniper leaf litter on limestone slopes and mesatops. Bell Co.: LS 769, Coryell Co.: LS 3886

Spiranthes cernua (L.) Rich., nodding ladies' tresses. Native, perennial. Occasional along banks of creeks and other damp areas. Bell Co.: LH 5537, Coryell Co.: **LH 5486**

Spiranthes magnicamporum Sheviak, Great Plains ladies' tresses. Native, perennial. Occasional along banks of creeks and other damp areas. Bell Co.: **LH 5541**, Coryell Co.: **LH 5487**

Poaceae

Aegilops cylindrica Host, jointed goat grass. Introduced, annual. Occasional in disturbed grasslands. Bell Co.: LS 2772, Coryell Co.: LS 2828

Andropogon gerardii Vitman, big bluestem. Native, perennial. Frequent in woodlands, where protected from grazing. Bell Co.: **LS 1428**, Coryell Co.: **LH 5276**

Andropogon glomeratus (Walter) Britton, Sterns, & Poggenb., bushy bluestem. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LS 2999, Coryell Co.: **LH 5558**

Andropogon virginicus L., broomsedge bluestem. Native, perennial. Frequent near banks of creeks and other damp areas. Bell Co.: **LH 5552**, Coryell Co.: **SKJ s.n.**

Aristida longespica Poir. var. *geniculata* (Raf.) Fernald, slim-spike three-awn. Native, annual. Occasional on sandy soils and post oak woodlands. Coryell Co.: **LH 6244**

Aristida oligantha Michx., oldfield three-awn. Native, annual. Common in disturbed grasslands. Bell Co.: LS 4591, Coryell Co.: LS 2085

Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey, red three-awn. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 3578, Coryell Co.: LS 2821

Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred, blue three-awn. Native, perennial. Common in disturbed grasslands on dry rocky limestone. Bell Co.: LH 5042, Coryell Co.: LH 5017

Aristida purpurea Nutt. var. *purpurea*, purple three-awn. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2474, Coryell Co.: LH 5012

Aristida purpurea Nutt. var. *wrightii* (Nash) Allred, Wright's three-awn. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 3296, Coryell Co.: LS 2822

Arundo donax L., giant reed. Introduced, perennial. Occasional along banks of creeks and disturbed roadsides. Bell Co.: LH 5529, Coryell Co.: **LH 5302**

Avena fatua L., wild oats. Introduced, annual. Common on roadside shoulders and seeded areas, cultivated, persisting. Bell Co.: **LH 4755**, Coryell Co.: LH 4900

Avena sativa L., oats. Introduced, annual. Frequent on roadside shoulders and seeded areas, cultivated, persisting. Bell Co.: **LH 5927**, Coryell Co.: LH 4752

Bothriochloa barbinodis (Lag.) Herter, pinhole bluestem. Native, perennial. Common in disturbed grasslands. Bell Co.: LH 4940, Coryell Co.: LS 3398

Bothriochloa bladhii (Retz.) S.T. Blake, Caucasian bluestem. Introduced, perennial. Occasional in disturbed grasslands and seeded areas, cultivated, persisting. Coryell Co.: **LH 5110**

Bothriochloa ischaemum (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan, King Ranch bluestem. Introduced, perennial. Common in most habitats, cultivated, persisting. Bell Co.: LH 5170, Coryell Co.: LS 2080

Bothriochloa laguroides (DC.) Herter ssp. *torreyana* (Steud.) Allred & Gould, silver bluestem. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 3265, Coryell Co.: LS 3889

Bothriochloa longipaniculata (Gould) Allred & Gould, long-spike silver bluestem. Native, perennial. Frequent in grasslands. Bell Co.: **LH 4937**, Coryell Co.: **LS 3891**

Bothriochloa pertusa (L.) A. Camus, pitted bluestem. Introduced, perennial. Frequent in disturbed grasslands and seeded areas, cultivated, persisting. Bell Co.: **LH 5393**, Coryell Co.: **LH 5969**

Bouteloua curtipendula (Michx.) Torr. var. *caespitosa* Gould & Kapadia, side-oats grama. Native, perennial. Common in grasslands. Bell Co.: SMKL 218, Coryell Co.: LH 6243

Bouteloua curtipendula (Michx.) Torr. var. *curtipendula*, side-oats grama. Native, perennial. Common in grasslands. Bell Co.: LS 3257, Coryell Co.: LS 2866

Bouteloua dactyloides (Nutt.) J.T. Columbus, buffalo grass. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2692, Coryell Co.: LS 2552

Bouteloua hirsuta Lag. var. *hirsuta*, hairy grama. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2051, Coryell Co.: **LS 2897**

Bouteloua hirsuta Lag. var. *pectinata* (Featherly) Cory, tall grama. Native, perennial. Common in grasslands on rocky limestone. Bell Co.: LS 4483, Coryell Co.: LS 4428

Bouteloua rigidiseta (Steud.) Hitchc., Texas grama. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 1853, Coryell Co.: LS 2454

Bouteloua trifida Thurb., red grama. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 1680, Coryell Co.: **LS 2912**

Briza minor L., little quaking grass. Introduced, annual. Rare in sandy soil. Coryell Co.: **LH 5669**

Bromus arvensis L., field brome. Introduced, annual. Common in disturbed grasslands. Bell Co.: LS 2493, Coryell Co.: LS 2414

Bromus catharticus Vahl, rescue grass. Introduced, annual. Common in disturbed grasslands. Bell Co.: LS 1800, Coryell Co.: LS 2234

Bromus pubescens Muhl. ex Willd., downy brome grass. Native, perennial. Frequent in mesic wooded canyons and riparian corridors. Bell Co.: LS 4244, Coryell Co.: **LS 3393**

Bromus tectorum L., cheatgrass. Introduced, annual. Frequent in disturbed grasslands. Bell Co.: **LS 2346**, Coryell Co.: **LH 6529**

Catapodium rigidum (L.) C.E. Hubbard ex Dony, catapodium. Introduced, annual. Occasional in disturbed areas. Bell Co.: **LH 6478**, Coryell Co.: **LS 3385**

Cenchrus spinifex Cav., common sandbur. Native, perennial. Frequent in sandy soils and disturbed areas. Bell Co.: **LS 3294**, Coryell Co.: **LS 4404**

Chasmanthium latifolium (Michx.) Yates, Indian woodoats. Native, perennial. Common in mesic wooded canyons and riparian corridors. Bell Co.: LS 1988, Coryell Co.: LS 3970

Chloris andropogonoides Fourn., slim-spike windmill grass. Native, perennial. Rare in disturbed grasslands. Bell Co.: **LS 3300**

Chloris ciliata Sw., fringed windmill grass. Native, annual or perennial. Rare in disturbed grasslands. Bell Co.: **LH 5449**, Coryell Co.: **LH 6634**

Chloris cucullata Bisch., hooded windmill grass. Native, perennial. Occasional on roadside shoulders and disturbed areas. Coryell Co.: **LS 3423**

Chloris subdolichostachya Muell., short-spike windmill grass. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 4382, Coryell Co.: **LS 2096**

Chloris verticillata Nutt., tumble windmill grass. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2811, Coryell Co.: **LS 1903**

Chloris virgata Sw., feather finger grass. Native, annual. Occasional on roadside shoulders and disturbed areas. Bell Co.: **LH 6671**, Coryell Co.: **LS 4475**

Coelorachis cylindrica (Michx.) Nash, Carolina joint-tail. Native, perennial. Frequent on sandy soils and post oak woodlands. Bell Co.: LH 6604, Coryell Co.: **LH 5013**

Cynodon dactylon (L.) Pers., Bermuda grass. Introduced, perennial. Common in grasslands, seeded areas, and damp soil. Bell Co.: LS 4389, Coryell Co.: **LS 2542**

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark, needle-leaf rosette grass. Native, perennial. Rare on a wooded limestone slope. Coryell Co.: **CC 1441**

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *acuminatum*, tapered rosette grass. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LH 5171, Coryell Co.: LS 3969

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark, Lindheimer's rosette grass. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LH 4927, Coryell Co.: LH 4915

Dichanthelium depauperatum (Muhl.) Gould, starved rosette grass. Native, perennial. Rare on a wooded limestone slope. Bell Co.: **RKGL 452**

Dichanthelium laxiflorum (Lam.) Gould, open-flower rosette grass. Native, perennial. Rare in post oak woodlands and sandy soil. Bell Co.: **LS s.n.**

Dichanthelium linearifolium (Scribn. ex Nash) Gould, slim-leaf panicgrass. Native, perennial. Rare in sandy soil and post oak woodlands. Coryell Co.: **LS 2608**

Dichanthelium malacophyllum (Nash) Gould, soft-leaf rosette grass. Native, perennial. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LS 3376**

Dichanthelium oligosanthes (Schult.) Gould var. *oligosanthes*, Heller's rosette grass. Native, perennial. Occasional in woodlands. Bell Co.: **LS 1799**

Dichanthelium oligosanthes (Schult.) Gould var. *scribnerianum* (Nash) Gould, Scribner's rosette grass. Native, perennial. Common in woodlands. Bell Co.: **LH 5770**, Coryell Co.: **LH 5880**

Dichanthelium pedicellatum (Vasey) Gould, cedar rosette grass. Native, perennial. Occasional on dry open limestone slopes and mesas. Bell Co.: LH 5901, Coryell Co.: LS s.n.

Dichanthelium sphaerocarpon (Elliot) Gould, round-seed rosette grass. Native, perennial. Rare in sandy soil and post oak woodlands. Coryell Co.: JW 261

Dichanthium annulatum (Forssk.) Stapf, Kleberg bluestem. Introduced, perennial. Frequent in disturbed grasslands and seeded areas, cultivated, persisting. Bell Co.: **LH 5896**, Coryell Co.: LH 6530

Dichanthium sericeum (R. Br.) A. Camus, silky bluestem. Introduced, perennial. Frequent in disturbed grasslands and seeded areas, cultivated, persisting. Bell Co.: **LH 6603**

Digitaria ciliaris (Retz.) Koel., southern crab grass. Introduced, annual. Frequent in alluvial floodplains and disturbed areas. Bell Co.: LH 6206, Coryell Co.: **LS 3412**

Digitaria cognata (Schult.) Pilger, western witch grass. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2981, Coryell Co.: **LS 4405**

Digitaria pubiflora (Vasey) Wipff, Carolina crabgrass. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2662, Coryell Co.: LS 2530

Echinochloa colona (L.) Link, jungle-rice. Introduced, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2945, Coryell Co.: **LS 4398**

Echinochloa crus-galli (L.) P. Beauv., common barnyard grass. Introduced, annual. Common along banks of creeks and other damp disturbed areas. Bell Co.: LH 5195, Coryell Co.: **LH 5388**

Echinochloa muricata (P. Beauv.) Fernald, rough barnyard grass. Native, annual. Frequent along banks of creeks and other damp areas. Coryell Co.: **LH 5391**

Echinochloa walteri (Pursh) A. Heller, coast cockspur grass. Native, annual. Occasional along banks of creeks and other damp areas. Bell Co.: LH 5194

Eleusine indica (L.) Gaertn., Indian goose grass. Introduced, annual. Occasional on roadside shoulders, lawns, and disturbed areas. Coryell Co.: **LS 4478**

Elymus canadensis L., Canada wild rye. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2583, Coryell Co.: LS 2444

Elymus virginicus L., Virginia wild rye. Native, perennial. Common along banks of creeks and ponds. Bell Co.: LS 4388, Coryell Co.: LS 2550

Eragrostis barrelieri Daveau, Mediterranean love grass. Introduced, annual. Common along roadside shoulders and disturbed areas. Bell Co.: LS 3502, Coryell Co.: LS 2963

Eragrostis cilianensis (All.) Vign. ex Janchen, stink grass. Introduced, annual. Frequent in disturbed areas. Bell Co.: LH 5176, Coryell Co.: **LH 5553**

Eragrostis curtipedicellata Buckley, gummy love grass. Native, perennial. Common in sandy soil, grasslands, and open woodlands. Bell Co.: LS 2771, Coryell Co.: LS 3399

Eragrostis curvula (Schrad.) Nees, weeping love grass. Introduced, perennial. Rare on roadside shoulder, seeded area, cultivated, persisting. Bell Co.: LH 5895

Eragrostis hirsuta (Michx.) Nees, big-top love grass. Native, perennial. Frequent in sandy soil, grasslands, and open woodlands. Bell Co.: **LH 5157**, Coryell Co.: **LS 2078**

Eragrostis intermedia Hitchc., plains love grass. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2923, Coryell Co.: **LS 3421**

Eragrostis pectinacea (Michx.) Nees ex Steud. var. *pectinacea*, spreading love grass. Native, annual. Frequent in damp, disturbed areas. Bell Co.: LS 3501, Coryell Co.: **LH 5059**

Eragrostis secundiflora J. Presl ssp. *oxylepis* (Torr.) S.D. Koch, red love grass. Native, perennial. Frequent in sandy soil and post oak woodlands. Coryell Co.: LS 1953

Eragrostis sessilispica Buckley, tumble love grass. Native, perennial. Frequent in sandy soil and post oak woodlands. Coryell Co.: LH 6026

Eragrostis superba Peyr., Wilmann's love grass. Introduced, perennial. Common in disturbed grasslands. Bell Co.: **LS 2833**, Coryell Co.: **LS 2871**

Eragrostis trichodes (Nutt.) Alph. Wood, sand love grass. Native, perennial. Common on rocky limestone mesatops. Bell Co.: **LS 2924**, Coryell Co.: **LS 3400**

Eriochloa sericea (Scheele) Munro ex Vasey, Texas cup grass. Native, perennial. Frequent in grasslands. Bell Co.: LS 2725, Coryell Co.: **LS 2820**

Erioneuron pilosum (Buckley) Nash, hairy tridens. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LS 1802, Coryell Co.: LS 2294

Festuca versuta Beal, Texas fescue. Native, perennial. Rare in mesic woodlands along streams and in canyons. Bell Co.: WRC 17549

Glyceria striata (Lam.) Hitchc., fowl manna grass. Native, perennial. Frequent along damp banks of creeks and ponds. Bell Co.: LH 5198, Coryell Co.: **LH 6738**

Hilaria belangeri (Steud.) Nash, common curly-mesquite. Native, perennial. Frequent in grasslands on dry rocky limestone. Bell Co.: LS 2691, Coryell Co.: **LS 2878**

Hordeum pusillum Nutt., little barley. Native, annual. Common in grasslands and open woodlands. Bell Co.: LS 1877, Coryell Co.: LS 2227

Koeleria macrantha (Ledeb.) Schult., prairie Junegrass. Native, perennial. Rare in undisturbed grasslands. Bell Co.: **SEW H-412** (TEX)

Leersia oryzoides (L.) Sw., rice cut grass. Native, perennial. Frequent along damp banks of creeks and ponds. Coryell Co.: **LS 3440**

Leersia virginica Willd., white grass. Native, perennial. Frequent in mesic wooded canyons and along damp banks of creeks and ponds. Bell Co.: LH 6482, Coryell Co.: **LH 5483**

Leptochloa dubia (Kunth) Nees, green sprangletop. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LH 4968, Coryell Co.: **LS 2965**

Leptochloa fusca (L.) Kunth ssp. *fascicularis* (Lam.) N. Snow, bearded sprangletop. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: **LS 3500**, Coryell Co.: **LH 5060**

Leptochloa panicea (Retz.) Ohwi ssp. *mucronata* (Michx.) Nowack, red sprangletop. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LS 2980, Coryell Co.: **LS 4488**

Limnodea arkansana (Nutt.) L.H. Dewey, Ozark grass. Native, annual. Common in grasslands and open woodlands. Bell Co.: LH 4910, Coryell Co.: LH 4913

Lolium perenne L. ssp. *multiflorum* (Lam.) Husnot, Italian rye grass. Introduced, annual or perennial. Frequent on disturbed roadside shoulders and disturbed areas. Bell Co.: LS 1867, Coryell Co.: LS 2265

Lolium temulentum L., rye grass. Introduced, annual. Occasional on disturbed roadside shoulders and disturbed areas. Bell Co.: LS 2492, Coryell Co.: LH 4944

Melica nitens (Scribn.) Nutt. ex Piper, three-flower melic grass. Native, perennial. Rare in mesic woodlands. Coryell Co.: **LH 6531**

***Muhlenbergia involuta* Swallen,** canyon muhly. Native, perennial. Rare in seasonally seeping limestone soil. Bell Co.: **LH 6238**

Muhlenbergia lindheimeri Hitchc., Lindheimer's muhly. Native, perennial. Rare in seasonally seeping limestone soil. Bell Co.: LH 6239

Muhlenbergia reverchonii Vasey & Scribn., seep muhly. Native, perennial. Common in seasonally seeping limestone soil and along unshaded creek banks. Bell Co.: LS 1430, Coryell Co.: LS 2091

Muhlenbergia schreberi J.F. Gmel., nimble-will. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LS 1966, Coryell Co.: **LH 5122**

Muhlenbergia sobolifera (Muhl. ex Willd.) Trin., Rock muhly. Native, perennial. Rare on sandy Pleistocene terrace deposits. Coryell Co.: **LH 6195**

Muhlenbergia sylvatica Torr. ex A. Gray, forest muhly. Native, perennial. Rare along wooded riparian corridor. Bell Co.: **LS 2796**

Nassella leucotricha (Trin. & Rupr.) Pohl, Texas winter grass. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 1797, Coryell Co.: LS 2243

Neeragrostis reptans (Michx.) Nicora, creeping love grass. Native, annual. Occasional along banks of ponds and other damp areas. Bell Co.: LH 5475

Panicum bergii Arechav., Berg's panicgrass. Introduced, perennial. Rare in a disturbed grassland. Bell Co.: **LH 5150**

Panicum capillare L., witch grass. Native, annual. Common in grasslands on dry rocky limestone. Bell Co.: LH 5119, Coryell Co.: LH 5293

Panicum coloratum L., Klein grass. Introduced, perennial. Common in disturbed grasslands. Bell Co.: **LS 3256**, Coryell Co.: **LH 6030**

Panicum dichotomiflorum Michx. var. *dichotomiflorum*, fall panicum grass. Native, annual. Frequent in damp, disturbed areas. Bell Co.: LH 5118, Coryell Co.: **LS 3451**

Panicum diffusum Sw., spreading panicum. Native, perennial. Rare in sandy soil. Coryell Co.: **LH 6538**

Panicum hallii Vasey var. *hallii*, Hall's panicum. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: LH 5965, Coryell Co.: LS 2740

Panicum obtusum Kunth, vine-mesquite. Native, perennial. Common in grasslands. Bell Co.: LH 4963, Coryell Co.: LS 2879

Panicum virgatum L., switch grass. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LS 2926, Coryell Co.: LH 5329

Paspalidium geminatum (Forssk.) Stapf, Egyptian paspalidium. Introduced, perennial. Occasional in shallow water near banks of ponds. Coryell Co.: LH 4948

Paspalum dilatatum Poir., Dallis grass. Introduced, perennial. Common along banks of creeks and in disturbed areas. Bell Co.: LS 3255, Coryell Co.: **LS 2815**

Paspalum distichum L., knot grass. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 4924, Coryell Co.: **LH 5061**

Paspalum floridanum Michx., Florida paspalum. Native, perennial. Frequent along banks of creeks and ponds and other damp areas. Bell Co.: LS 4592, Coryell Co.: **LH 5325**

Paspalum notatum Fluegge var. *latiflorum* J. Doll, Bahia grass. Introduced, perennial. Rare in disturbed grasslands and roadside shoulders. Bell Co.: **LH 6672**

Paspalum pubiflorum Rupr. ex Fourn., hairy-seed paspalum. Native, perennial. Common along banks of creeks and other damp areas. Bell Co.: LH 5327, Coryell Co.: LH 4953

Paspalum setaceum Michx., thin paspalum. Native, perennial. Frequent on rocky limestone mesatops and in post oak woodlands. Bell Co.: LS 2976, Coryell Co.: LS 3380

Paspalum urvillei Steud., Vasey grass. Introduced, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: **LS 2512**, Coryell Co.: LH 5387

Phalaris caroliniana Walter, Carolina Canary grass. Native, annual. Frequent in damp soil of creek banks and roadside ditches. Bell Co.: LH 4829, Coryell Co.: LS 2709

Poa annua L., annual bluegrass. Introduced, annual. Common in disturbed areas. Bell Co.: LH 6335, Coryell Co.: LS 2268

Poa arachnifera Torr., Texas blue grass. Native, perennial. Common along riparian corridors and in post oak woodlands. Bell Co.: LS 2384, Coryell Co.: LH 6315

Polypogon monspeliensis (L.) Desf., annual rabbit's foot grass. Introduced, annual. Frequent along banks of creeks and other damp areas. Bell Co.: LH 5686, Coryell Co.: **LS 2562**

Polypogon viridis (Gouan) Breistr., water bent grass. Introduced, perennial. Frequent along banks of creeks and ponds. Bell Co.: LS 2518, Coryell Co.: **LS 2557**

Schedonnardus paniculatus (Nutt.) Trel., tumble grass. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 2584, Coryell Co.: LS 2671

Schedonorus phoenix (Scop.) Holub, tall fescue. Introduced, perennial. Rare along banks of creeks and rivers. Bell Co.: **LH 5940**, Coryell Co.: **LH 6072**

Schizachyrium scoparium (Michx.) Nash var. *scoparium*, little bluestem. Native, perennial. Common in grasslands and open woodlands. Bell Co.: **LS 1431**, Coryell Co.: LS 2089

Setaria parviflora (Poir.) Kerguelen, knot-root bristle grass. Native, perennial. Frequent along banks of creeks and other damp areas. Bell Co.: LH 5534, Coryell Co.: LS s.n.

Setaria pumila (Poir.) Roem. & Schult. ssp. *pumila*, yellow bristle grass. Introduced, annual. Frequent in disturbed areas. Bell Co.: LH 5070, Coryell Co.: LS s.n.

Setaria reverchonii (Vasey) Pilger ssp. *ramiseta* (Scribn.) W.E. Fox, Rio Grande bristle grass. Native, perennial. Occasional on sandy soils and post oak woodlands. Bell Co.: **LS 2471**, Coryell Co.: **LH 5843**

Setaria reverchonii (Vasey) Pilger ssp. *reverchonii*, Reverchon's bristle grass. Native, perennial. Common in grasslands on dry rocky limestone. Bell Co.: **LH 5160**, Coryell Co.: BRJ 59

Setaria scheelei (Steud.) Hitchc., southwestern bristle grass. Native, perennial. Common in open woodlands. Bell Co.: LS 2930, Coryell Co.: **LH 5286**

Setaria viridis (L.) P. Beauv. var. *viridis*, green bristle grass. Introduced, annual. Occasional in disturbed areas. Bell Co.: LS 2803, Coryell Co.: **LH 6566**

Sorghastrum nutans (L.) Nash, yellow Indian grass. Native, perennial. Common in grasslands and open woodlands. Bell Co.: LS 2062, Coryell Co.: **LS 2092**

Sorghum halepense (L.) Pers., Johnson grass. Introduced, perennial. Common in grasslands and disturbed areas. Bell Co.: LS 2589, Coryell Co.: LS 2409

Sphenopholis obtusata (Michx.) Scribn., prairie wedgescale. Native, annual. Common along banks of creeks and other damp areas. Bell Co.: LH 5882, Coryell Co.: **LH 5949**

Sporobolus clandestinus (Biehler) Hitchc., purple-flower dropseed. Native, perennial. Frequent in post oak woodlands. Bell Co.: LH 5375, Coryell Co.: LS 2095

Sporobolus compositus (Poir.) Merr. var. *compositus*, tall dropseed. Native, perennial. Common in disturbed grasslands. Bell Co.: LS 3429, Coryell Co.: LS 2865

Sporobolus compositus (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi, meadow dropseed. Native, perennial. Common in grasslands and open woodlands. Bell Co.: **LS 2979**, Coryell Co.: **LS 2090**

Sporobolus cryptandrus (Torr.) A. Gray, sand dropseed. Native, perennial. Frequent in grasslands and open woodlands. Bell Co.: RKGL 509, Coryell Co.: LS 2905

Sporobolus neglectus Nash, puff-sheath dropseed. Native, annual. Common in disturbed grasslands and along roadside shoulders. Bell Co.: **LH 6286**

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood var. *ozarkanus* (Fernald) Shinners, Ozark dropseed. Native, annual. Common in disturbed grasslands and along roadside shoulders. Bell Co.: LH 5554, Coryell Co.: **LH 5551**

Sporobolus vaginiflorus (Torr. ex A. Gray) Alph. Wood var. *vaginiflorus*, poverty dropseed. Native, annual. Frequent in disturbed grasslands and along roadside shoulders. Bell Co.: CLY 53079 (TEX), Coryell Co.: LS 3433

Stenotaphrum secundatum (Walter) Kuntze, St. Augustine grass. Introduced, perennial. Rare along banks of a creek, possibly a waif, persisting. Bell Co.: **LH 5149**

Tridens albescens (Vasey) Woot. & Standl., white tridens. Native, perennial. Common in damp soil along banks of creeks and disturbed areas. Bell Co.: LS 1858, Coryell Co.: **LS 1948**

***Tridens congestus* (L.H. Dewey) Nash,** pink tridens. Native, perennial. Rare in damp soil along banks of a creek. Bell Co.: **LH 5932**

Tridens flavus (L.) Hitchc. var. *flavus*, purpletop. Native, perennial. Common in open woodlands. Bell Co.: LH 5197, Coryell Co.: **LS 3424**

Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners, rough tridens. Native, perennial. Common on rocky limestone slopes and mesatops. Bell Co.: LS 3268, Coryell Co.: **LS 2874**

Tridens muticus (Torr.) Nash var. *muticus*, slim tridens. Native, perennial. Frequent on rocky limestone slopes and mesatops. Bell Co.: BRJ 58, Coryell Co.: **LS 3434**

Tripsacum dactyloides (L.) L., eastern gamma grass. Native, perennial. Occasional along banks of creeks and in damp soil. Bell Co.: LS 2519

Trisetum interruptum Buckley, prairie trisetum. Native, annual. Common in grasslands and open woodlands. Bell Co.: LH 5911, Coryell Co.: **LH 5844**

Triticum aestivum L., common wheat. Introduced, annual. Rare on roadside shoulders and seeded areas, cultivated, not persisting. Bell Co.: KSRS 1066 (CMML), Coryell Co.: LH 6741

Urochloa fusca (Sw.) B.F. Hansen & Wunderlin, browntop. Native, annual. Occasional in disturbed areas. Bell Co.: LH 5105, Coryell Co.: SMKL 160

Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fernald, sixweeks fescue. Native, annual. Common in grasslands and disturbed areas. Bell Co.: LS 1786, Coryell Co.: **LS 1826**

Pontederiaceae

Heteranthera limosa (Sw.) Willd., blue mud-plantain. Native, perennial. Rare in damp mud. Coryell Co.: **LH 6568**

Potamogetonaceae

Potamogeton nodosus Poir., long-leaf pondweed. Native, perennial. Frequent in ponds and lakes, submersed. Bell Co.: LH 5478, Coryell Co.: **LH 5294**

Smilacaceae

Smilax bona-nox L., saw greenbrier. Native, perennial. Common in most habitats, climbing onto shrubs and trees. Bell Co.: LS 1872, Coryell Co.: LH 4748

Smilax tamnoides L., bristle greenbrier. Native, perennial. Common along riparian corridors, climbing onto shrubs and trees. Bell Co.: LH 5290, Coryell Co.: LH 5121

Typhaceae

Typha domingensis Pers., narrow-leaf cat-tail. Native, perennial. Common in shallow water or mud near banks of creeks, ponds, and other damp areas. Bell Co.: LS 3303, Coryell Co.: **LS 3284**

Typha latifolia L., broad-leaf cat-tail. Native, perennial. Frequent in shallow water or mud near banks of creeks, ponds, and other damp areas. Bell Co.: LH 6019, Coryell Co.: **LH 5928**

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FIRST REPORT OF *PERSICARIA HISPIDA* (POLYGONACEAE) FROM NORTH AMERICA NORTH OF MEXICO (TEXAS)

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ABSTRACT

Persicaria hispida is reported for North America north of Mexico for the first time. The species was discovered growing in stock-tanks on two ranches in Starr County, Texas. A duplicate of one of the collections (*Carr et al. 20568*) was sent to the William and Lynda Steere Herbarium at The New York Botanical Garden where it was identified as *Persicaria hispida* in 2009.

Key Words: new record, Starr County, Texas, Tamaulipan Thornscrub Ecoregion

RESUMEN

Persicaria hispida se cita de América del Norte al norte de México por primera vez. La planta fue descubierta creciendo en un tanque de ganado en dos ranchos en el Condado de Starr, Texas. Un duplicado de una de las colecciones (*Carr et al. 20568*) fue enviado al Herbario William y Lynda Steere del Jardín Botánico de Nueva York, donde fue identificado como *Persicaria hispida* en 2009.

INTRODUCTION

The purpose of this paper is to report the discovery of a previously undocumented *Persicaria* (L.) Miller species for the flora of North America north of Mexico and to provide a description and exsiccate to facilitate monographic, floristic, ecological and conservation efforts.

This striking species was first encountered in Texas during a botanical inventory of a ranch in southern Starr County, an area rich in globally-rare species of the Tamaulipan Thornscrub Ecoregion (Fig. 1a). In April 2002, the junior author made a brief stop at a small, steep-sided stock tank and expected to tally the suite of low-growing species that characterize the flora of such sites during drought periods. These species include *Cynodon dactylon* (L.) Pers., *Phyla nodiflora* (L.) Greene, *Eryngium nasturtiifolium* Juss. ex Delarbre, *Glinus radiatus* Ruiz & Pavon) Rohrb., and *Calibrachoa parviflora* (Juss.) D'Arcy. The aforementioned species were present, but a taller plant caught our attention first and resulted in an excited conversation full of joyful expletives not usually associated with field work in South Texas. Although the species was immediately recognized as a member of the genus *Persicaria*, its robust, hispid stems, large ocreae and glutinous leaves excluded it from any *Persicaria* known from Texas. In December 2009, a second Texas population of *Persicaria hispida* was located during an inventory of a different Starr County ranch located about 6–7 air miles west-northwest of the first tank. The second tank had a clay bottom and was nearly full of water at the time. *Persicaria hispida* (H.B.K.) M. Gómez. occupied the deeper parts of the tank, occurring as a lone emergent species while other species, such as *Chloracantha spinosa* (Benth.) G. L. Nesom, *Eleocharis palustris* (L.) Roem. & Schult and *Cynodon dactylon* were visible along the shoreline. Both tanks were on ranches that were actively grazed by cattle and also supported small populations of white-tailed deer.

Persicaria hispida is a distinctive species that ranges from southern South America, north to northern Mexico and now documented in Texas. *Persicaria orientalis* (L.) Spach is the only other *Persicaria* in North America that is hispid throughout, has leaf blades ovate, more than 3 cm wide and ocreae margins (apices) broadly rotate and photosynthetic. The two species may be distinguished by the following key.

1. Terrestrial from taproot; whole plant hirsute or strigose, not stipitate-glandular; leaf blade bases truncate, rounded or cordate; inflorescences ascending or drooping; perianth eglandular; garden escape _________ **P. orientalis**
1. Aquatic or semi-aquatic from rhizomes; whole plant hispid and stipitate-glandular; leaf blade bases cuneate; inflorescences stiffly erect; perianth glandular; native _________ **P. hispida**

Persicaria hispida (H.B.K.) M. Gómez, Anales Inst. Seg. Enseñanza La Habana 2:278. 1896. *Polygonum hispidum* H.B.K., Nov. Gen. Sp. Pl. 2: 178. 1817, non *Polygonum hispidum* Buch.-Ham. ex D. Don, Prodr. Fl. Nepal. 71. 1825. TYPE: COLOMBIA. "prope urbem Carthago in devexis Andium Quinduensium, alt. 530 hex. Floret Martio," *Humboldt & Bonpland s.n.* (HOLOTYPE: B n.v. [photo NY]).

Perennial herb, aquatic or sub-terrestrial, 0.5–1.5 m tall, hispid, punctate and stipitate-glandular; rhizomes procumbent, 1–3.5 cm diameter at the nodes, glabrous. Stems erect or ascending, ca 0.8–1.8 cm diameter at the nodes, glabrous or setose, sparse or densely stipitate-glandular, setae appressed to spreading, 1–3 mm long, glands sub-sessile to stipitate. *Ocreae* tubular, 1.8–3.2 cm long, membranaceous, setose (rarely glabrous), stipitate-glandular, punctate, setae (when present) spreading, the apex spreading and undulate (hypocrateriform), 0.3–1.5 cm long, chartaceous and photosynthetic, ± glabrous, sparse stipitate-glandular, punctate, the limb margin crenate and sometimes also dentate, bristly. *Leaves* cauline; petioles 2–8 cm long, stipitate-glandular, hispid; blade ovate, narrow-ovate or oblong-ovate, (5.5–)8.5–27 × 3–11.5 cm, chartaceous, both surfaces densely punctate, setose throughout when young to merely setose on the veins in age, rarely the adaxial surface glabrous and epunctate, the base rounded to truncate then cuneate, long-decurrent on the petiole, the margins entire, subcrenate, densely setose, setae acroscopic, appressed or ascending, the apex acute to acuminate; venation pinnate, the lateral veins 13–30 pairs, arcuate-ascending, hispid or bristly, abaxially prominent. *Inflorescences* sub-terminal, erect, essentially 2-sub-dichotomously branched from a leafy axil, 9–20 cm long, the primary fork basal, producing a shorter divergent peduncle with a solitary, terminal raceme and longer, secondary fork, sub-dichotomously branched into subequal, terminal racemes, the primary and secondary branch axils with reduced ocrea, the second axil rarely also with a reduced leaf, the peduncles setose or strigose, stipitate-glandular; racemes stout, dense, continuous, 3–10 × 1–2 cm; bracts imbricate, ovate, (2.5–)3–5 × 1.5–2.5 mm, glabrous to sparse-strigose, punctate and sometimes also stipitate-glandular, longitudinally striate, the margins entire, glabrous or short-setose, setae 0.2–1.5 mm long. *Flowers* ca 5 per fascicle-like partial inflorescence; pedicels exserted, exceeding the bracts by 1–2 mm; perianth turbinate or campanulate, pink, purple, reddish or greenish/white, punctate, the tepals 5, 3–4 mm long, unequal, oblong, the apices obtuse, the outer 2 cuculate, the inner 3 concave to plane, accrescent and tightly investing the achene; stamens 5, scarcely exserted, the anthers pink; nectaries 5, alternating with the stamens; ovary short-stipitate, ovoid, the style bifid ca 1/2 the length, slightly exserted; stigmas minute, capitate. *Achenes* inserted, biconvex, (2.7–)3.0–3.3 × 2.6–2.9 mm, thickest at the base, one face plane or slightly concave, the other face convex and sometimes with a slight central tumescence, the base obtuse, rounded or truncate, the apex obtuse to acuminate, the style deciduous, the stipe persistent 0.1–0.2 mm long, white; pericarp blackish brown, minutely rugose, lustrous.

Native to the Americas from central Argentina to Texas, including the Greater Antilles (Cuba); river banks, swamps, lagoons, ponds and wet ditches, usually in open, disturbed sites; 0–1400 m.

North and Central American specimens examined: **U.S.A. Texas. Starr Co.:** ca 7.0–7.1 air mi N to NNE of jct. US 83 and F.M. 755 in Rio Grande City, ca 0.5 mi S of La Sagunada Rd. from a point 3.7 road mi W of jct. F.M. 755, Eladio Carrera Ranch, Rio Grande City North Quadrangle, 26°28.678'N, 98°47.200'W, ± Elev. 290–300 ft, 3 Apr 2002, *W. Carr, D. Carrera, L. Williams & L. Elliott 20568* (NY, TEX-LL); near Arroyo Los Olmos ca. 7.6 air mi NNW of jct. R. M. 755 and Eisenhower Rd. in Rio Grande City, Rio Grande City North Quadrangle, 26°29'24.2"N, 98°51'21.1"W, 220–230 ft, 10 Dec 2009, *W. Carr & G. Janssen 28735* (TEX-LL). **MEXICO. Michoacan:** Estrero del Rio Popoyuta, 25 km al NE de Lázaro Cárdenas, 6 Sep 1979, *M. González G. 234* (NY). **Chiapas:** Mun. Tuxtla Gutiérrez, Tuxtla Gutiérrez, 1900 ft, 27 Feb 1965, *D.E. Breedlove 9195* (TEX-LL); Mun. Arriaga, 6 km N of Arriaga, 250 m, 14 Aug 1972, *D. Breedlove 26923* (NY, TEX-LL). **GUATEMALA. Department unknown:** San Juan de Dios, Oct 1865, *G. Bernoulli 139* (NY). **Jalapa:** Jalapa, 4500 ft, 8 Jan 1908, *Kellerman 7865* (NY). **Guatemala:** Guatemala City, 10 Mar 1947, *J. Brenckle 47-212* (NY). **HONDURAS. Comayagua:** near Siguatepeque, 1050 m, 9 Jul 1936, *Yunker et al. 5770* (NY). **Francisco Morazán:** Santa Lucía, 10 km NE of Tegucigalpa, 1400 m, 27 Apr 1985, *C. Bendeck 177* (NY); El Hatillo, 15 km N de Tegucigalpa, 1400 m, 20 Mar 1985, *C. Garcia 143* (NY); Río Guacerique, between Los Laureles and Las Tapias, NW of Tegucigalpa, 1000 m, 4 Nov 1966, *A. Molina 18573* (NY); San Antonio de Oriente town, 1000m, 17

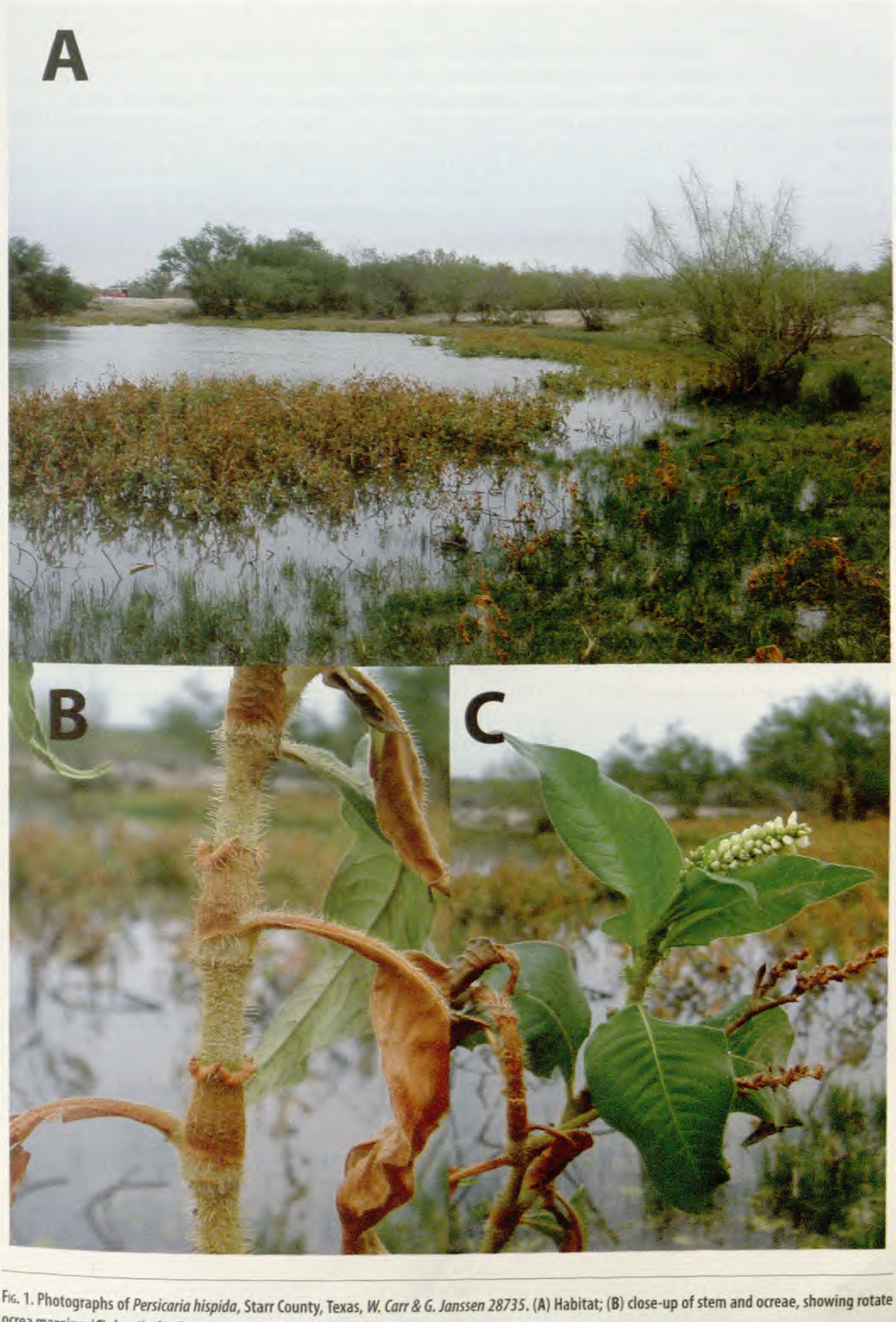

FIG. 1. Photographs of *Persicaria hispida*, Starr County, Texas, *W. Carr & G. Janssen 28735*. (**A**) Habitat; (**B**) close-up of stem and ocreae, showing rotate ocrea margins; (**C**) detail of inflorescence. Photographs by William Carr.

Aug 1971, *A. Molina 26198* (NY); new highway of El Zamorano, Yeguare River valley, 800 m, 17 Aug 1976, *A. Molina & A. Molina 31531* (NY); km 7 to Tegucigalpa, vicinity of La Calera, 1000 m, 10 Jun 1999, *A. Molina & A. Molina 34788* (TEX-LL); Santa Lucia, 10 km NE of Tegucigalpa, 1400 m, *S. Solabarrieta 173* (NY). **Ocotepeque:** vic. of Ocotepeque town, bed of Marchala River, 800 m, 30 Aug 1968, *A. Molina 22495* (NY). **El Paraiso:** jnct. Rio Choluteca & Hwy 4, 650 m, 18 Jun 1970, *G. Davidse & R. Pohl 2129* (NY); Quebrada de Coyol, Sierra El Chile, entre El Junquillo y El Robledal, 1300m, 12 Jun 1964, *A. Molina 14178* (NY). **NICARAGUA. Esteli:** 22 air km NNE of Esteli along road to Yalí, Quebrada Plan Helado, 13°13'N, 86°15'W, 1360 m, 23 Jun 1982, *R. Haynes 8568* (NY). **COSTA RICA. Alajuela:** Canton de Los Chiles, R.N.V.S. Caño Negro, Llanura de Guatuso, boca del Río Caño Negro, 10°54'50"N, 84°46'05"W, 40 m, 22 Jun 1993, *K. Martínez et al. 151* (NY); Refugio Caño Negro, Los Chiles, San Carlos, 10°53'N, 84°47'W, 30m, 8 Jul 1987, *N. Zamora & I. Chacón 1372* (NY). **PANAMA. Colon:** small tributary of Quebrada Ancha, 4 km E of Buena Vista, 3 km N of cement plant, 80 m, 4 Sep 1973, *Nee 6781* (NY); Chagres River near Juan Mina, 2 Jul 1940, *H. Bartlett & T. Lasser 16356* (NY).

In his monograph of *Polygonum* s.l. of North America, Small (1895) listed the distribution of this species as "The West Indies, Central America and northern and eastern South America as far south as Paraguay." The species is now known from North America north of Mexico as well. Despite being widespread from central Argentina to Texas, the species is uncommon (esp. northward), though sometimes locally abundant. It is absent from Guyana, Surinam and French Guiana (Brandbyge 1997); the Lesser Antilles (Howard 1988); the Yucatan (Ortiz 1994), Belize (Balick et al. 2000); Los Tuxtlas, Veracruz, Mexico (Ibarra-Manríquez & Sinaca-Colín 1987); the region in and around Mexico City (Rzedowski 1979); and the Bajio region of central Mexico (Castillejos Cruz & Solano 2008). It appears to be most abundant in Bolivia and Argentina. In Honduras, it has been called "tabaquillo" (*Molina & Molina 31531*) and "tabacón" (*Molina & Molina 34788*). More study is needed to determine the conservation status of this species in Texas. It is currently known from only two populations, both on disturbed sites. More data is needed on the distribution in northern Mexico to determine whether this is a natural range extension or a casual introduction.

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